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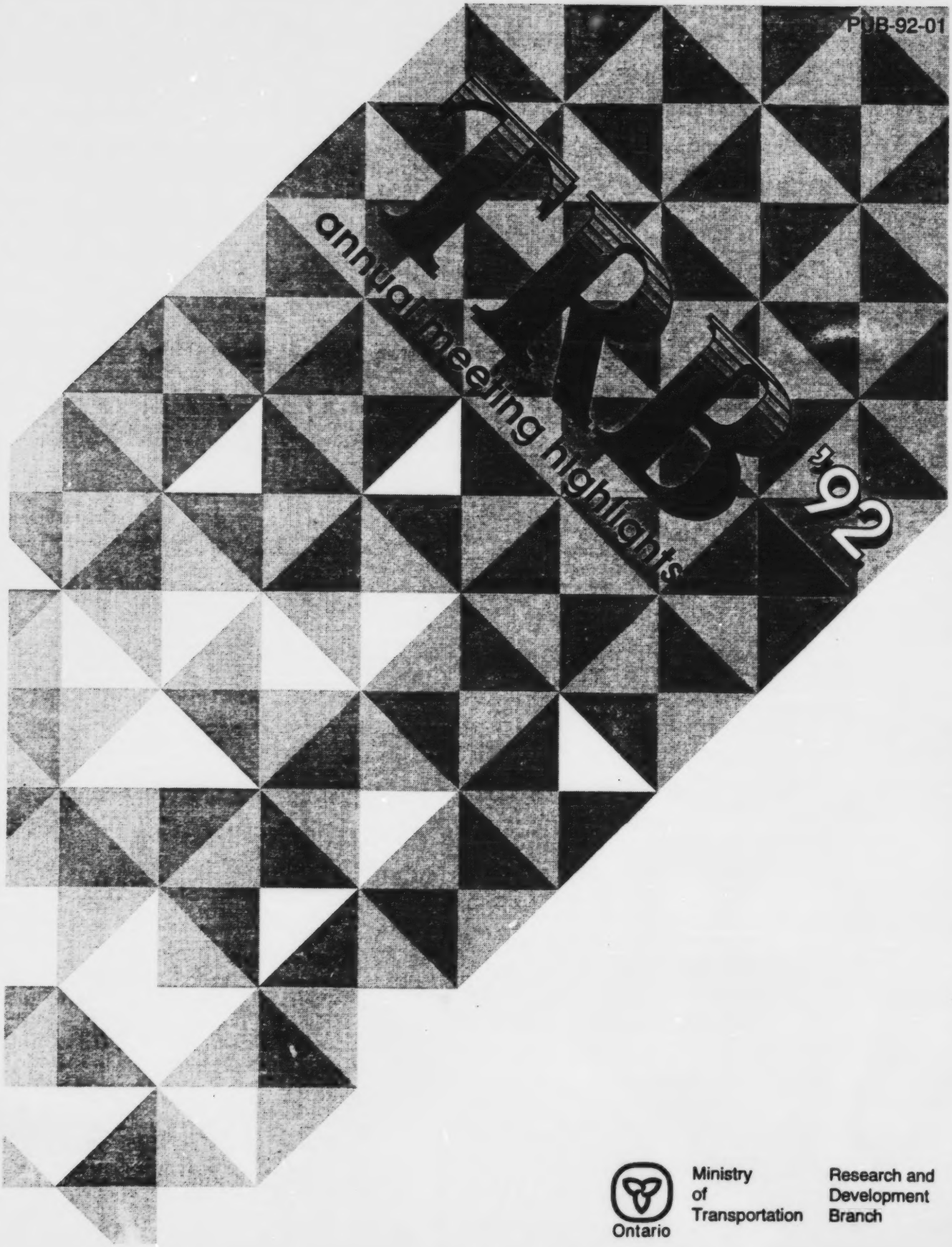

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TRB '92 – Annual Meeting Highlights

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Abstract: The Highlights of the TRB '92 Annual Meeting as presented by Ministry staff in their trip reports.

(Available to Ministry staff only.)

Comments: The trip reports published herein are unedited, and unoffical. They are very much the personal views of the authors. For these reasons, the document is available only to Ministry staff.

Key Words: TRB, transportation research, National Research Council

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TRB '92

Annual Meeting Highlights

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TRB '92

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TRB '92

Foreword

TRB Annual Meeting, January 1992

The Annual Meeting of TRB is a vital forum for the exchange of information on many aspects of transportation. This annual collection of "Highlights" is an important way of sharing personal observations and highlights of the annual meeting with those who could not attend.

If you are interested in more information on a certain subject, I suggest that you contact the author of the particular trip report. The reports are reproduced without editing or any attempt to co-ordinate the information on one issue in one place. In addition, copies of presented papers are with the Ministry's Library.

The authors of each report are thanked for their contribution to making the TRB deliberations so accessible to the rest of us.

As the Ministry's representive to TRB, please call upon me if you need any advice or assistance in dealing with them.

Graham Jones
Director (acting)

Research & Development Branch
235- 4707

TRB '92

Quality and Standards

B. Bakht

Principal Research Engineer

Structures Office
Research & Development Branch
235-4674

SIGNIFICANT OBSERVATIONS RE: PRESENTATIONS AT THE TRB ANNUAL MEETING, JANUARY 12 - 16, 1992

1. Survey of Shapes of Soil-steel Bridges

(A2K04 meeting, morning, January 12)
Sam Musser of Syro Steel is conducting a U.S.-wide survey of the shapes of soil-steel bridges in distress. In his survey, the conduit shapes will be recorded by manual tape measurements. It is comforting to note that we have already started such a survey and that our survey method by photogrammetry is far more efficient and reliable.

2. Advanced Composite Materials

(Semi-formal meeting, evening, January 13)
A very informative meeting was held with various researchers in the field of advanced composite materials' application to bridges. A report on this meeting and other ACM related meetings, which I could not attend because of conflict with other meetings, is provided by Aftab Mufti.

3. Autostress Design

(Session 89, morning, January 14)
Once again, I was convinced that the problem of redistribution of load effects in continuous girder bridges should not be studied by considering a continuous girder in isolation as is done in the Autostress design.

4. CLSM

(Informal meeting with Bill Brewer, afternoon, January 14)
At last year's TRB meeting, I was quite excited at the potential of Controlled Low Strength Material (CLSM) for use as backfill in soil-steel bridges. Several phone contacts with Bill Brewer during the last year were topped with this meeting. Bill is very knowledgeable in the field and is not miserly in giving out advice and information. In consultation with G. Abdel-Sayed of Windsor University, who also attended the meeting, I have formulated some thoughts on the use of CLSM in soil-steel structures, and hopefully will propose a test installation this year.

5. Bridge Testing

(A2C05 meeting, morning, January 15)
A report by the committee indicated a significant increase in the bridge testing activity in the U.S. Florida tested 50 bridges last year. I am a little sceptical of these tests because no effort seems to have been made on rationalizing the test data. For example, in the Florida tests it was considered enough to find that the measured deflections were about 60% of the predicted deflections in bridges with prestress concrete girders. When asked about the reason for the discrepancy, the presenter replied that he was too busy testing bridges to find time to investigate each tests results in detail.

6. Impact Factors in Bridges

(A2C05 meeting, morning, January 15)
Measurement of the elusive impact factor from test data continued to amuse researchers. An impact factor of 0.6 was "measured" in a bridge in West Virginia. The test was conducted under a light vehicle but the presenter was (wrongly) confident that the same value is also applicable to heavier vehicles.

Baidar Bakht
Structures Research Office
January 31, 1992

TRB '92

Quality and Standards

N.R. Close

Supervisor

Maintenance Office
Transportation Operations Branch
235-3662

TRANSPORTATION RESEARCH BOARD
71ST ANNUAL MEETING
1992

TRIP REPORT

ATTENDEE: N. R. Close
Maintenance Office
Transportation Operations Branch
Quality and Standards Division

COMMITTEE A2A05, Landscape and Environmental Design

I attended the business meeting of this committee of which I chair the Research Needs Subcommittee. This is the 60th anniversary year for this committee.

The A2A05 Committee is concerned with design parameters that relate to the protection, conservation, restoration and enhancement of the natural environment and man-made elements of transportation systems and their surroundings. Factors of interest include: aesthetic and scenic quality and visual integration of facilities into their environment; conservation of natural elements, preservation of cultural and historic resources; identification and preservation of scenic opportunities and quality development of roadside facilities to enhance travel experiences.

SESSION 57: VISUALIZATION FOR ENVIRONMENTAL PLANNING

Producing Defensible Visualization (preprint available)

Presentation reviewed three technologies used to present visualization of transportation projects in Texas. Although the video imagery used by Texas has never been legally challenged, the same technique has been successfully used against them.

Advances in the Microcomputer Visualization of Environmental Factors in Highway Planning

Presentation also showed three increasingly expensive methods of presenting visual imagery of highway projects ranging from standard raster images using overlaying vectors and geographically referenced to video photographs overlaid with CADD generated drawings to full computer animation.

Imaging the Future: New Technology for Visualizing Highway Planning

An interesting inventory and analysis of the Mass Turnpike where the 135 mile length was photographed every 200 feet using a 35mm movie camera mounted on a truck travelling at 40 mph. Data was transferred to video disk and digitally integrated by the Harvard School of Design. Most of the cost was "data acquisition". Once the data is acquired it can be used in a variety of ways and it is geographically referenced.

Advanced Computerized 3-D Visualization Techniques Applied to Transportation Projects

Visualization of the I-17 and I-40 Interchange in Arizona. A viewshed analysis of the four tier interchange was not understood by public review. At a second public meeting, artist renderings were similarly misunderstood so the state transportation planners decided to let CADD represent the project. VideoCADD merges the picture and coordinates, it looks ok but I expected more.

SESSION 72: SCENIC BYWAYS COAST TO COAST AND RUSSIA

Seaway Trail Suggested Applications for a National Scenic Byway

Presentation on New York State's Seaway Trail concentrating on the tourist opportunities and benefit to local business. An excellent presentation by the Executive Director illustrating the benefit of working with NYDOT, local business and government to create a positive environment for opportunity. Directly applicable to Ontario as the Seaway Trail extends from Lake Erie, Lake Ontario and along the St. Lawrence River on the American side of the lakes. Some reference material available.

Scenic Byways: Their Selection and Designation

A pretty basic method of taking qualitative visual data and quantitatively analyzing it based on a numerical ranking system used by Kansas. Some argument from other presenters on values assigned but overall not a bad method of dealing with aesthetics from an engineering viewpoint.

Designing Scenic Byways in Virginia

The legal and bureaucratic steps involved in categorizing and classifying roads to meet scenic byway criteria. A fairly dry presentation outlining the criteria, procedures

and adoption of Design Standards for scenic byways.

User Preferences in Scenic Byway Development on the Oregon Coast

An analysis of highway user preference on views and scenic quality in Oregon. Used as a basis for upgrading roads and especially road amenities (ie streetscape furniture, landscaping, lighting, signing and advertising) through coastal towns and areas of "scenic integrity" by Oregon DOT.

Task Force A5T57: Task Force on Scenic Byways and Recreational Travel (synopsis paper available)

The Task Force has been charged with the review of Scenic Byways, currently a hot topic with TRB and State Agencies. Legislation in the US was included under the 1991 Intermodal Surface Transportation Efficiency Act. Various interest groups are all lobbying for position and responsibility with this issue. The research component of scenic byways will probably fall under Committee A2A05.

SESSION 103: GEOMETRIC DESIGN OF INTERCHANGES, PART 1

Interchange Planning and Design: A Historical Perspective

An interesting review of grade separated design in the US starting with the first interchange in New Jersey in 1928. A quick analysis of design alternatives including the original cloverleaf, parclo A and B, various diamond options and full system interchanges.

Human Factors Associated with Interchange Design Features

A review of driver error sources including: excessive task/processing demands, unusual manoeuvres, poor sight distance, deficient information displays and violated expectancies. Violated expectancies took up most of the presentation and were defined as odd designs that didn't meet the driver's expectations. Driver's don't expect left exits, lane drops, exits at point of tangent and exiting to stay on the mainline facility. One other point of interest was that the age of those driving the freeways is up significantly and is expected to keep going up.

The Interchange Study and Selection Process: A State Highway Agency Perspective

A review of the Texas Interchange Selection Process, TRIP (Texas Ranking of Interchange Projects). Looked at factors including: the system (freeway to freeway), service (on/off

access), design consistency, functional classification and spacing (signing/weaving). Interchanges are prioritized by design alternatives, ranking process and a cost/benefit analysis. Interchange design alternatives are limited by constraints such as ROW availability, environmental, traffic demand and construction traffic handling. The diamond interchange and its variations are the most popular design in Texas based on simplicity, economical design, narrow ROW and wrong way ramp movements.

SESSION 117: HIGHWAY TRAFFIC NOISE AND ABATEMENT

Bionomic Boulevards: Green Notes From A Passing Car

A tongue-in-cheek look at aesthetic design from an unorthodox architect. A slide show profiling the projects of Site Architects of New York City including parking lot and theme park design with a message to noise barrier designs to consider the aesthetic.

SESSION 133: GEOMETRIC DESIGN OF INTERCHANGES, PART 2

Ramp Geometrics: Alignment and Superelevation Design (preprint available)

A technical review of recent research and survey data on interchange design. The following major principles were discussed; aging population, large truck/trailer combinations, spiral curves, superelevation rates, speed differential and vertical/horizontal coordination.

SESSION 143: SOCIAL AND ECONOMIC FACTORS: DO THEY MATTER?

In Public Transportation as an Investment

A consultant review of the options available to municipal transit officials and politicians in Philadelphia when faced with an aging transit system. The options varied from close the facility down immediately, phased shut down, piecemeal improvement or full scale rehabilitation. The process showed that the use of public funds in transportation leverages a large amount in transportation-related activities. The consultant stated that $80 billion in US transportation leverages $3 trillion in related activity.

Environmental Consequences as a Design Input to the Boston Central Artery Project

A review of the planning, design and environmental review process for the $5 billion construction of I-93 through

Boston. This was an open, receptive process that listened to public and interest group comment and tried to act on the comments. The consultant stated that there should be a refined design stage after draft EIS (Environmental Impact Statement) and before final EIS so that draft comments can be acted upon. There was a problem in communicating with an untrained public and visualization techniques were used, however the consultant stated that a 3-D model was by far the best method of having everyone clearly understand the undertaking. The environmental justification for the facility was interesting and included a rationalization of reducing the trip time through Boston by 2½% resulting in an annual distance saving of 700 + million trip miles using certain assumptions per vehicle. This parlayed into 52 million saved vehicle hours of travel and a corresponding large reduction on vehicle emissions.

SESSION 172: VEGETATION MANAGEMENT ON MILITARY INSTALLATIONS AND HIGHWAY RIGHTS-OF-WAY

Plant Growth Regulators for Vegetation Management at Military Installations

The research was conducted at four military sites, geographically dispersed and known for low maintenance. Three treatments were employed: PGR's (plant growth regulators), PGR's plus herbicide and herbicides alone. This looked like a good comparative study for MTO or Hydro rights-of-ways. In summary, PGR's are cost effective if you have a high number of mowings per season. If you only mow once a month the cost savings disappear.

Revegetation of Steep Slopes in Cool and Transitional Climates

The research concentrated on ammunition bunkers located in cool or transitional climates. The bunkers tend to be built on 2:1 slopes using waste material with 2 feet of cover on the roof and 4 feet of cover on the side slopes. The areas receive little or no maintenance. Slope orientation is critical all bunkers are built with a N-S or E-W orientation. Those with a south slope exposure exhibit plant tolerances for more moderate zones. Tall fescue and legumes work the best for rehabilitation. Fertilization studies show that a good presence of grasses result in improved growth, poor turf cover results in improved weed growth.

Roadside Wildflower Meadows: A Summary of the Benefits and Guidelines to Successful Establishment and Management (preprint available)

The ideal of total wildflower cover is a myth more than a reality according to researchers at the University of Massachusetts. To obtain a mono-culture display requires establishment and cultural techniques. Wildflower stands are not always sustainable or sustainable in density, they tend to get overgrown or the species composition changes. This paper is a good review of practices and procedures showing that a Natural Revegetation Program is the normal succession to wildflower programs. Stopping mowing in certain areas achieved the same result as an intensive $2 K per acre wildflower planting and scalloped edges and mowing regimes created a more natural, yet managed, appearance.

Weed Management in Roadside Wildflowers

The basic underlying principle of this long-time farmer-cum-researcher from North Carolina State University is that you can't sustain wildflower plantings due to plant succession. It is only natural for plants to succeed one another and these monocultural displays fly in the face of mother nature. An interesting and knowledgable presentation.

Technical Aspects of Wetlands Delineation/Evaluation and Their Management Implications Along Transportation Corridors

A long and drawn out discussion on wetland definition and the legal and management implications arising from the definition and limits. Primarily of use to the US and of limited value to MTO.

TRB '92

Quality and Standards

T. J. Kazmierowski

Manager

Pavement Design, Evaluation & Management Section
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235-3512

Conference Report
71st TRB Meetings

This report summarizes papers of interest presented at TRB sessions dealing with recycled tire rubber, stone mastic asphalts, cold in-place recycling, flexible pavement construction and overlay design, and Total Quality Management. Preprint papers identified with an * are available from the undersigned.

Session 16 - RECYCLED TIRE RUBBER IN ASPHALT PAVEMENTS

* **An Overview of the Design and Construction of Asphalt Paving Materials with Crumb Rubber Additive**
- Michael A. Heitzman, Federal Highway Administration

- overview of technology to set framework of session
- highway uses for crumb rubber: - shredded tire for lightweight embankment fill
  - crumb rubber additive (CRA) either ground or granulated
- material costs: - 12¢ → 15¢ U.S. per lb for granulated
  - 25¢ U.S. per lb for ground
- wet process, blended with A.C. to give a modified binder (asphalt rubber)
- dry process, added at hot mix plant, rubber aggregate (rubber modified hot mix)
- Issues - performance and cost - 50 → 100% higher than conventional H.M.
  - recycling CRA mix - limited experience
  - environment - the jury is still out
  - design and construction guidelines - still being developed.

Virginia's Experimentation with Asphalt Rubber Concrete
- G.W. Maupin, Jr., Virginia Transportation Research Council

- Virginia's philosophy, additional cost for use of CRA to be offset by improved performance.
- 2 test sections using wet process were placed in 1990 to address rutting and reflection cracking concerns
- too early to report on performance but summarized lab test results
- % voids typically failed for rubber, while passed for control mixes
- control has higher (30%) creep modules vs. rubber mixes and similarly lower gyratory shear strength
- developed reaction (viscosity vs. time) curves for coarse and fine crumb at 5, 10 and 15% CR experienced large jumps in viscosity at 15% CR (pass #16 sieve)
- 0.6% more A.C. required for the coarse rubber mixes when compared to fine rubber mixes
- optimum value of 5 → 10% of fine rubber content based on indirect tensile strength
- summary, rubber mixes may be less resistant to imposed stresses than conventional mixes based on lab testing, presently awaiting performance results.

* **An Overview of Caltrans Experience with Rubberized Asphalt Concrete**
- Jack L. Van Kirk, CalTrans

- 26 projects going back to 1978 with rubber modified A.C.
- performance indicates reduced reflection cracking particularly when applied to thin pavement sections in conjunction with a SAMI (stress absorbing membrane interlayer)
- Mix Design typical @ 300° F with 20-30% higher binder content and lower void content
- Advantages of RAC over DGAC: - increased fatigue resistance
  - lower permeability/reduced oxidation
  - higher abrasion resistance and reduced layer thickness
  - should all add up to lower maintenance costs
- no mention of recycling experiences with these mixes, however, an informative paper.

* **Florida's Approach Using Ground Tire Rubber in Asphalt Concrete Mixtures**
  - Randy C. West, Florida Department of Transportation

- Florida experience with wet process and lower CR %
- major consideration is to enhance performance without jeopardizing future recycling
- mod. binder allows greater film thickness and less drain down for O.F.C. mixes
- discussed several demonstration projects
- strength testing indicates optimum of 5% rubber for D.G. hot mix
- no rutting or cracking in 2½ years performance for modified D.G. mixes
- OFC demonstration included 10% ground rubber, with blending, production, and laydown operations same as conventional paving procedures
- Present specifications:

	OFC	DGFC	SAMI
Ground Rubber %	12%	5%	20%
Max. Grad.	#40	#80	#20

- Florida anticipates good long term performance but have no handle on actual costs.

Recycled Tire Rubber in Asphalt
- Russell H. Schnormeier, Russ' ENCORP

- information presentation on tire components, use of rubberized A.C.
- somewhat optimistic presentation on the advantages of rubber modified hot mix.

Advances in Technology of Asphalt Paving Materials Containing Used Tire Rubber
- Barry Takallou, BAS Engineering Consultants

- discussed major barriers to widespread use of asphalt rubber
- claims to have developed an optimum binder to allow for 6 day storage of blended product at 10% of A.C. content
- discussed Ontario's dry process demonstration project particularly the environmental monitoring component.

* **Use, Availability, and Cost-Effectiveness of Asphalt Rubber in Texas**
  - Cindy K. Estakhri, Texas A&M University System

- presentation on Texas experience with asphalt rubber
- used mainly in chip seal followed by interlayers, crack sealants, and recently in hot mix
- asphalt rubber chip seals have been used to waterproof concrete pavements
- have experienced 7 → 14 years of life for asphalt rubber chip seals
- 30% increase in costs for SAMI } Costs of
  50% increase in costs for Hot Mix } asphalt
  100% increase in costs for Chip Seals } rubber
- Recommendations – don't go overboard with use of asphalt rubber
  - tire rubber not in the best interest of the public
  - let sound engineering dictate rehab. method.

A Study of the Effectiveness of SBR Latex in Asphalt Concrete Mixes
- Ray Brown, National Center for Asphalt Technology

- 5 year performance study on the use of SBR latex (wet process) in dense graded mix
- demonstration project in Alabama
- no significant difference in cracking, rutting, PSI and condition rating between latex modified and conventional hot mix
- latex modified sections cost on average 14% more with no significant increase in performance
- abstract listing all Recycled Tire Rubber in Asphalt Pavements papers was made available at this session.

Session 187 - <u>ALTERNATIVE ASPHALT MIXTURES TO RESIST PERMANENT DEFORMATION</u>

Use of Stone Mastic Asphalt in Germany
- Ottmar W. Schutz, William Schutz Construction, Germany

- split or stone mastic developed in Germany in early 60's to resist abrasion and instability rutting

- principle of SMA is to maximize coarse aggregate content, i.e. the majority of traffic load is carried by stone skeleton
- skip or gap graded, 70% of aggregate retained on #8 sieve
- only high quality double crushed coarse aggregate is specified
- manufactured sand and limestone filler are specified plus stabilizing additives
- 60 - 80 pen asphalt cement (A.C. 20)
- fibres used to prevent drain down of A.C.
- addition of polymer extends the characteristics of A.C. and improves adhesion of A.C. to the aggregate
- 50 blow marshall to each side of briquette is specified
- production is similar to conventional dense graded hot mix
- critical that additives are spread equally throughout mix, hence 5 → 10 seconds extra dry and wet mix time
- 200 - 300 g/cm^2 tack coat placed prior to SMA placement
- static 10 ton steel wheel roller used, no pneumatic tire or vibratory rolls are required
- rollers operate near to paver, typically 6-8 passes of roller, difficult to compact when mix cools
- broadcast mix blends in very easily
- rich mix ensures a high quality longitudinal mix
- 20 → 30% higher cost for SMA
- SMA is a very flexible yet durable mix.

* **State of the Art: Use of Stone Mastic Asphalt in Germany**
  - Peter A.F. Bellin, Niedersaechsisches Landesamt fuer Strassenbau, Germany

- SMA is a standard mix throughout Western Europe
- use a performance spec. requiring contractor warranty
- high PSV aggregates specified
- A.C.: 65 pen for heavy traffic
  80 pen for normal traffic
- with 11 mm grad. use 6.5 → 6.8 A.C. content
- cellulose fibres used in 80% of all mixes
- polymers may result in segregation at high mixing temperatures (350°C)
- also cellulose fibres are cheaper as an additive
- 8 mm and 6 mm SMA top size results in a thinner application and a quieter riding surface course
- best method is to premix additive/A.C. and keep agitated
- high paving temp. ≈ 300°F
- cannot compact at temperatures below 200°F, results in crushing of agg.
- initial spread of 1 lb. of agg./yd^2 of 1 → 3 mm aggregates to ensure skid resistance of initial rich surface
- excellent state-of-the-art presentation of Germany's experience.

* **Stone Mastic Asphalt for Very Thin Wearing Courses**
  - Jean-Pierre Serfass, SCREG Routes, France

- thin surface courses are used due to diminished structure strengthening requirements of existing road and provide quality surfaces
- specify a heavy tack coat for sealing and bonding, 500 to 900 g/cm^2 of emulsion, polymer modified emulsion for heavy trafficked areas
- fibres fix high asphalt contents plus reinforce the mastic
- fibres result in a rich but stable mastic
- mix design is largely empirical
- typical mix proportions are given in paper
- pavers travel at 8 → 12 ft. minute
- static medium weight rollers are specified
- early surface appears rich but traffic wears off richness quickly
- 8 year old sections show no ravelling, rutting, or loss of skid resistance

Panel Discussion:

- disagreement on the use of choke stone for initial surface safety
- French SMA mixes are more permeable and hence require a thick tack coat; German mixes appear denser and require only a thin tack coat.

Stone Mastic Asphalt Practice in the United States
- John Bukowski, Federal Highway Administration

- overview of experience in U.S. during 1991
- gradations follow German spec with 70% coarse 30% fine gap graded
- typically used 60-80 pen. (A.C. 20)
- used cellulose fibres, mineral fibre and polymer modifiers
- used marshall mix design procedure
- conventional placement procedures used but early and quick compaction required.

Use of Stone Mastic Asphalt - Georgia Experience
- Ron Collins, Georgia Department of Transportation

- SMA and porous European mix test sections
- 2 million ESAL annual loading on test site
- A.C.-30 with 5% Novopalt binder
- mineral filler was Georgia marble
- hydrated lime used as anti-strip additive
- 35 sec. wet mix time
- 325 - 340°F mix temp.
- greater quality control on stockpiles, sieves, etc.
- rolling pattern
  - 3 passes vibratory breakdown
  - 3 passes static intermittent
  - 3 passes static final rolling

Use of Stone Mastic Asphalt: Michigan Experience
- Dan Vreibel, Michigan Department of Transportation

- placed both batch and drum SMA mixes
- A.C. 20, cellulose fibres, and crushed limestone dust filler
- achieved 4.5 → 6% compacted air voids
- cellulose fibres used in pellet form
- concerns with % flat and elongated.

Stone Mastic Asphalt Materials Characterization
- Ray Brown, Auborn University

- carried out lab tests on changes in A.C. content, gradation and fibre content for Michigan SMA mixes.
- changes in A.C. content result in:
  - little tensile strength change
  - little change in unit weight
  - drop in voids as A.C. dropped
  - VMA increases as A.C. increased
- changes in sand gradation results in:
  - no significant tensile strength change
  - significant changes in unit weight
  - significant changes in void content
  - VMA changed significantly
    * critical to control sand in SMA mixes
- changes in Filler Content result in:
  - expected tensile strength changes
  - change in unit weight
  - normal change in voids
  - affects VMA as expected
- changes in Fibre Content result in:
  - slight change in unit weight
  - little effect on voids
  - little effect on VMA
- gyratory shear stress better for SMA than dense graded mixes
- critical to control SMA gradation particularly on #4 and #200 sieves.

SMA Summary
- James A. Scherocman, Cincinnati, Ohio

- Europeans don't use bag house fines as mineral filler
- aggregate properties: SMA mixes require clean, rough, durable aggregates
- fine aggregates are predominantly manufactured sand
- mineral filler - key for air void and VMA
  - need to know type, gradation
- addition of filler is a problem, ensure you have capability to introduce quickly and positively
- stabilizing agents must be properly dispersed - modify dry and wet mix times
- A.C. contents: - with fibres 6.0% → 7.5%
  - with polymers 5.5% → 6.5%
- mix design - 3% air void
- minimum rolldown, 1/8"/inch lift thickness of SMA
- we don't control aggregate gradation sufficiently - North Americans use graded aggregates
  - Europeans use single sized aggregates
- coat truck bed completely with release agent.

Session 154 - EMULSIFIED ASPHALT: USES AND PERFORMANCE

Cold In-Place Recycling for Rehabilitation and Widening of Low-Volume Flexible Pavements
- Rebecca S. McDaniel, Indiana DOT

- CIR used on widening 20' pavement to 24'
- upper 2" of hot mix intact, lower 4" badly stripped
- existing pen 36, A.C. 5.6%, 1900 AADT
- modified milling machine with spray bar attachment feeding paver
- 2½% emulsion, 2% residual
- CIR pavements performing much better, showing minimum reflection cracking particularly on longitudinal widening.

* **Use of Emulsions for In-Place Recycling: Oregon Experience**
- Ted Scholz, Oregon State University

- guide for agencies and contractors in the use of emulsions for recycling, good reference document for regional design and construction
- have recycled 50 ℄ miles of 2 lane pavement in Oregon, predominantly low volume rural highways
- predesign sampling uses a 16 inch milling unit to depth of recycling; MTO should incorporate this in our CIR spec.
- lab testing includes pen, gradation and A.C.
- mix design (emulsion content) consists of base design and adjusts for grad, A.C. content and penetration
- Oregon has departed from a rigorous mix design procedure since it didn't simulate field conditions
- also carry out % water required testing
- use steel wheel rollers for the thin lifts (50 mm) so as not to seal the surface, don't recommend pneumatic-tired rollers for breakdown. This is different from Ministry's current procedure of using rubber tired roller until it "walks out of the mix"
- don't overroll, can result in flushing or excess fines on surface
- water content; too much results in flushing and retards curing, too little results in segregation, ravelling, and/or high void contents
- curing of the mat is critical prior to sealing to ensure the success of CIR
- emulsions are 125°F and water 100°F
- paper identifies some performance problems and process control procedures to mitigate these.

* **Gap-Graded Cold Micro Asphalt Concretes: The Benefits of Polymer-Modified Asphalt Cement and Fibres**
- Maurice Vivier, Enterprise Jean Lefebvre, France

- EVA fibre modified asphalt cement for microsurfacing using gap graded mixes
- results in increased wear/shear resistance
- 6 years experience with high skid numbers still being achieved
- fibres cost 4% of total cost.

The Effects of Mineral Filler, Asphalt Content, and Curing Time on the Properties of Emulsion-Based Cold Mixes
- Ali A. Selim, South Dakota State University

- cold mixes should be cured for 1 day in mold and 2 days at 100°F; this results in higher stabilities, lower flow, high DBSG
- 10% mineral fillers improved mix properties
- comment: lab based paper, not very practical or useful.

* **In-Situ Cold Recycling of Bituminous Pavements with Polymer-Modified High Float Emulsions**
- Bob Williams, Santa Fe, New Mexico

- New Mexico uses a hot mix overlay (1½ → 3") in conjunction with CIR to handle the traffic volumes
- CIR saves 20-30% in costs over conventional rehab. techniques
- AASHTO structural coefficient of 0.25 → 0.3 for CIR material (hot mix is 0.4), Ministry uses a similar GBE (1.5)
- CIR mix design is only a starting point due to the many field variables, then carry out field adjustments
- specify a high float emulsion (HFE-150) normally and SBS polymer modified emulsion (HFE-150P) for high trafficked roads
- New Mexico's approach to compaction uses a minimum 30 ton pneumatic roller as breakdown (can wait up to 2 hours before compaction) and finishes with steel wheel
- also requires field molded briquettes and spec. 97% compaction of field molded briquettes.
- open to traffic 2 hours after compaction
- U.S. $1.92/yd^2/3¾" depth
- New Mexico uses 3" min. and 4" max. lifts of CIR
- state-of-the-art reference paper for CIR.

Session 38 - <u>FLEXIBLE PAVEMENT CONSTRUCTION: MATERIALS AND REHABILITATION</u>

Effects of Residential Moisture on Stripping Potential of Asphalt Concrete Mixtures
- Frazier Parker, Jr., Auburn University

- found consistent tensile strength - residual moisture content relationship for aggregates studied
- residual moisture provides a reasonable explanation for inconsistencies of lab and field performance
- stripping influence of residual moisture on dense dolomitic limestone is contrary to current thinking.

Construction of Rut Resistant Asphalt Mixtures
- Charles W. Manzione, Air Force Engineering & Services Laboratory

- asphaltic concrete can provide long term support for very high loads (30 kip axle loads)
- mix lab density must achieve field traffic conditions
- must ensure heavy enough field compaction to achieve gyratory densities.

Asphalt Technology for Hot In-Place Surface Recycling
- John J. Emery, John Emery Geotechnical Engineering

- we've heard this one many times before.

* **Performance of Cold In-Place Recycling in Ontario**
- Thomas J. Kazmierowski, Alison Bradbury, Sam Cheng, and Chris Raymond, Ontario Ministry of Transportation, Canada

Microwave Hot Mix Asphalt Recycling in Georgia
- James A. Scherocman, Cincinnati, Ohio

- process uses 90% RAP and 10% new aggregate
- feed into a counterflow dryer referred to as a preheater where recycling agent added
- used a 950 Megahertz microwave to raise mix to final discharge temperature
- average production rate of 90 tons/hour
- mix appearance and texture similar to conventional mixes with no air pollution
- cost savings were approximately 30% of cost for conventional recycled mixes
- only a small fraction of final heating is provided by microwave.

Session 123 - OVERLAY DESIGN

* **An Evaluation of Granular Overlays in Washington State**
  - Joe P. Mahoney, University of Washington
  - granular overlays typically designed 4" thick
  - reduces reflective cracking, strengthens, reduces frost related effects and reprofiles pavement
  - equivalent thicknesses based on elastic analysis and is a function of the stiffness (modulus) of the granular overlay (G.O.)
  - South African and WisDOT has much documented experience
  - 3" AC = 1" AC + 4" granular overlay
  - suggested 2:1 GBE would agree with Ontario's experience and design guidelines
  - larger crushed stone base gradation appears more effective as overlays
  - survival lives of ≈9 years for bituminous surface treatment on granular overlay versus 10 → 12 years for hot mix on granular overlays
  - back calculated modulus of elasticity in the range of 70 ksi.

ROADHOG: A Flexible Pavement Overlay Design Procedure
- Kevin D. Hall, University of Illinois
- based on FWD non-destructive testing
- uses response algorithm to back calculate resilient modulus of subgrade based on deflection reading 3' from applied load
- routine overlay design tool for State of Arkansas.

A Nationwide Evaluation Study of A.C. Overlays Placed on Fractured PCC Pavements

* **Asphalt Concrete Overlay Design Methodology for Fractured PCC Pavements**
  - Matthew W. Witczak, University of Maryland
  - study to identify design requirements and performance criteria to prevent reflection cracking of hot mix overlays on PCC pavements
  - fractured slab approach by:
    - crack and seat (JPCP), only technique Ministry has tried
    - break and seat (JRCP)
    - rubblize (JACP, JRCP, CRCP)
  - performance curves indicate rubblize service lives to be longest and is the preferred rehabilitation treatment
  - crack spacing decreased as subbase/subgrade modulus increased, i.e. 30" on subgrade to 6" on cement treated base
  - design should not exceed critical effective modulus of E_{CR} = 1,000 ksi to minimize reflective cracking while assuring structural adequacy.

Revision of AASHTO Pavement Overlay Design Procedures.

* **Field Testing of AASHTO Pavement Overlay Design Procedures.**
  - Kathleen T. Hall and Michael I. Darter, University of Illinois
  - modify Part III, Chapter 5 of AASHTO Guide to update and simplify the existing method
  - structural overlay procedure, not for safety concerns
  - final draft awaiting public comment, approval and incorporation into AASHTO Guide
  - revisions include 7 separate stand alone procedures for overlay design.

Session 92 - TOTAL QUALITY MANAGEMENT (TQM) IN DESIGN AND CONSTRUCTION: A NATIONAL PERSPECTIVE

* **Managing Quality - Time for a National Policy: Facing the Problem, Obstacles to Overcome, Fundamental Concepts, and Plan of Action**
  - Richard M. Weed, New Jersey DOT
  - Solution: Greater return on current investments
    - use better materials and design concepts
    - incorporate statistical quality assurance

- Plan of Action
  1. Top Management Awareness
  2. Make commitment to Quality
  3. Change Organization Concept
  4. Provide training program
  5. Develop qualified staff
  6. Use state-of-the-art methods
  7. Develop Implementation Plan.
- economic realities mandate that designed serviceability/durability are fully achieved in construction.

Can TQM Work in the Public Construction Arena?

- Thomas H. Oswald and James L. Burati, Jr., Clemson University

- what are the components of TQM?
  - customer/supplier relationship
  - employee involvement
  - team work
  - worked viewed as a process
  - statistical quality control
  - transformation of management
- foundation of TQM is customer satisfaction and continuous improvement
- TQM is a journey, not a destination
- TQM is the way to manage in the 1990's
- agencies must take lead with contractor accepting and participating in a team approach which stresses joint responsibility. Well trained people with dedicated goals and objectives are the key to achieving TQM.

Quality Management for Concrete Pavement Under Performance Standards

- James M. Shilstone, Sr., Shilstone & Associates, Inc.

- what is Quality (traditional definition)?
  - conformance to requirements
  - customer satisfaction
- input of tolerances (+, -) in requirements results in skewed project results
- we are missing a definition of how concrete pavement will perform for 30 → 40 years
- agency specifies performance and contractor submits his management plan; agency reviews and audits plan.

FHWA Demonstration Project No. 89, 'Quality Management', and a National Quality Management Initiative

- Donald R. Tuggle, Federal Highway Administration

- overview of federal initiatives and direction for achieving quality management.

T.J. Kazmierowski
Manager
Pavement Design, Evaluation
and Management Section

TRB '92

Quality and Standards

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Trip Report
71st Annual Meeting of the TRB
January 1992
Jerry Hajek

EXPERT SYSTEMS TECHNOLOGY
(Committee A5008 & Session 185)

The Expert Systems technology strives to harness the power of computers by manipulating data, information, and knowledge in the way experts do. There is renewed interest in this technology because of several successful applications, (e.g. in the area of traffic engineering, asphalt concrete mix design, and pavement performance evaluation and design). For example, of the six papers presented in Session 153 "Pavement Rehabilitation", three of these papers described an application of E.S. technology for pavement rehabilitation design.

Another reason is the recent availability of good commercial neural network software. Neural computing enables one to develop knowledge-based expert system applications without a model or without detailed understanding of the problem domain. I have obtained an interesting demonstration software on neural network computing form NeuralWare, Inc. It is also interesting to note that the majority of the knowledge-based E. S. applications presented at the 1992 T.R.B. were written in EXSYS.

The Expert System Technology is gaining a well reserved recognition. To facilitate its MTO use, some selected expert system software should be supported and monitored by the Computer Systems Branch. The EXSYS software appears to be a good starting candidate.

The Expert Systems Committee A5008 has been re-named Committee on Application of Artificial Intelligence. It is an active committee and I am heading its sub-committee on emerging applications.

AUTOMATED COLLECTION OF PAVEMENT DISTRESS DATA AND PAVEMENT EVALUATION TOPICS
(Committee A2B06, Session 4)

The technology for automated collection of pavement distress data is now commercially available. Ed Novak from the Michigan D.O.T. described their experience with "Semi-Automated Pavement Distress Surveys". Michigan routinely videotapes all freeways using three cameras to obtain simultaneous video images of both the roadway and the pavement. The pavement images are evaluated in the office

by a special team comprised of almost exclusively physically disadvantaged people. The total monitoring and evaluation cost is about $40.00 per freeway lane mile. Because of the interest expressed by several agencies, Michigan plans to have an "open house" to demonstrate the technology.

Another interesting presentation from Michigan (Seasonal Changes in the Longitudinal Profile of Pavements Subject to Frost Action) described the use of a G.M.-type non-contact profilometer (based on incandescent light) for evaluation of PCC slab stepping. Because of the precision of the profilometer (about 0.5 mm vertically and about 0.5 m horizontally), it is possible to measure the seasonal changes in slab stepping. This information helps Michigan to prioritize rehabilitation treatments and to design specific remedial treatments for individual pavement joints or transverse cracks.

ASTM is trying to standardize a new pavement roughness index. It is likely to be different from the IRI (International Roughness Index) now used by many agencies, including Michigan.

The state of-the-art for the automated pavement distress evaluation equipment remains Swedish PAVUE System, which uses five video cameras simultaneously. By combining roughness or profile data with video images, it can detect faulting (stepping) of pavement slabs.

PAVEMENT DESIGN ISSUES
(Committee A2B03, Sessions 77 and 232)

a) Load Equivalency Factors

The issue of Load Equivalency Factors (LEFs), the factors which quantify pavement damage caused by different truck axle loads, is one of the perennial issues of pavement design. The U.S. Trucking Research Institute has now released its new study based on the re-evaluation of the AASHTO Road Test data. The study's credibility rests on that of its principal investigator, Paul E. Irick, who was also responsible for the development of the original AASHTO's LEFs. The main conclusion of the new study is that the original AASHTO LEFs are too high, particularly for concrete (PCC) pavements. (In other words, the higher truck loads are not as damaging as previously assumed and particularly so for PCC pavements.)

b) Damage Potential of Wide-Based Single Tires

The FHWA has released the results of an extensive study conducted using their Accelerated Loading Facility at the Turner Fairbank Highway Research Centre. Pavement response and performance data were obtained by subjecting identical pavement structures to identical loads applied by either (a) traditional dual tires or (b) by a wide based single tire. For the pavements included in this experiment, the rutting under the single tire loading was approximately twice that for the dual tires and the fatigue life of the pavement exposed to the single tire loading was only one quarter of that for of the dual tires. Again, this was observed for identical pavements and axle loads with the only difference being the tire type. The FHWA is aware of the serious implications of these research results and plans another battery of tests this year. The FHWA is also studying a proposal to limit the loading on wide based single tires to about 7.5-8.0 kg/mm. (Our present regulations allow 11.0 kg/mm.)

These findings were supported by investigators from Texas A&M University (T. Akram et al, "Estimating Damage of Dual or Wide Base Tires with Multidepth Deflectometer) who reported a 2.5 fold reduction in pavement life attributable to the wide-base tires.

c) Would it be Asphalt or Concrete?

The Transportation Corridor Agencies of Orange County, California, have commissioned a comprehensive pavement selection study for 100 km of 4 to 6-lane toll roads ("Pavement Type Selection in Orange County, California" by A.H. Yourman et al). Life-cycle economic analysis were inconclusive. The final decision to select an asphalt concrete pavement over a PCC pavement was based, in part, on initial costs, compatibility with staged construction, and on large anticipated differential settlements of the earth works. The selected AC design is "full strength" and incorporates 75 mm thick layer of AC treated open-graded drainage material.

d) Overlay Design Issues

The interest in pavement deflection testing, Falling Weight Deflectometer (FWD) applications, and back-calculation of pavement layer moduli is still unabated. However, there is a new realism on the horizon and several investigators now realize that the basic need is to quantify the strength of the existing pavement (and to use this knowledge in the overlay

design) rather than to determine the pavement layer moduli per se. For example, K.D. Hall and P. Elliott (ROADHOG - A Flexible Pavement Overlay Design Procedure) have presented a practical, easy-to-use system for selecting A.C. overlay thickness developed for the Arkansas Highway and Transportation Department. The pavement structural strength, referred to in the report as stiffness, is quantified quite simply by the difference between two FWD surface deflections. Alabama's approach is to correlate FWD results with expert judgement. Similarly, the Ontario paper by D. Stolle and F.W. Jung (A Simplified, Rational Approach to FWD Interpretation) was very well received.

The AASHTO sponsored "Revision of AASHTO Pavement Design Procedures" (K.T. Hall, M. Darter, R. Elliott) has now been released. It strongly recommends deflection testing using preferably FWD.

GEOTEXTILE MATERIALS IN PAVEMENT DRAINAGE APPLICATIONS

I have met with Geo Koerner of the Geosynthetic Research Institute, Drexel University, who is conducting the field portion of an extensive NCHRP study on "Geosynthetics in Drainage Applications." So far, 83 sites in 14 states have been investigated by exhuming geosynthetic materials and the surrounding granular materials, and returning them to the laboratory for a complete analysis. Our study on subsurface pavement drainage (R & D project 21214) conducted by Dr. G. Raymond, Queen's University, will encompass only a dozen sites, but is more comprehensive: we are trying to link subsurface drainage with pavement performance. At any rate, a working relationship between the principals of the two studies as been established. Also, the results of both studies indicate the susceptibility of pre-manufactured pavement edge drains to clogging.

WEIGH-IN-MOTION (WIM) TECHNOLOGY (Committee A2B08)

There are three noteworthy developments:

1. The FHWA Demonstration Project DP-76 (a three-day program describing WIM and AVC technology using an executive overview, a classroom presentation, and a field installation and

demonstration in traffic; all based in a mobile home) may be available to Canadian audiences in 1992. I have contacted G. Williams regarding the possibility of the C-SHRP sponsoring this demonstration project in Canada.

2. Delaware, Maryland, New Jersey and Pennsylvania (together with the FHWA) have developed a Traffic Monitoring Evaluation Project on I-95 near Philadelphia. The objective of the project is to evaluate in the field 22 different, often competing traffic monitoring products (8 pavement-based Weigh-in-Motion (WIM) scales, 1 bridge-based WIM scale and 13 Automatic Vehicle Classification Systems). This is a very impressive evaluation project. Unfortunately, all pavement sensors were installed in rigid or composite pavements. Installation in flexible pavements is usually more demanding, and the evaluation results are more discerning. All products were supplied and installed free of charge by participating vendors which represent all the major North American suppliers. A Traffic Monitoring Tour of the site is now being organized by NASHTO for May 5, 1992.

3. Several high-profile research agencies based in New Mexico, including the Los Alamos National Laboratory, and the New Mexico State Highway and Transportation Department, have formed an entity called, "Strategic Alliance for Transportation Research." This opens the door to the transfer of new technology and expertise from military to civilian applications. The areas which are likely to benefit first include (a) sensor/detection technology (i.e. WIM, AVC, AVA) (b) non-destructive testing (acoustical, seismic, nuclear), and geo-positioning and geographic information systems. Note: The Los Alamos National Laboratory alone employs about 7,500 people.

SHRP PRODUCTS FOR HIGHWAY MAINTENANCE

The SHRP, Carnegie-Mellon University, University of California, and California D.O.T. are still spending a lot of money trying to develop a pavement crack sealing robot. CMU's conceptual design is based on an oversized X-Y plotter pulled by a truck; California's concept is based on mechanical arms mounted on a truck. Other areas which are enthusiastically supported by the SHRP include: (a) automated equipment that plugs potholes (to be operational in the fall of 1992), (b) ground penetrating radar to measure the thickness and moisture of pavement layers and, (c) application of seismic techniques for pavement investigations.

TRB '92

Quality and Standards

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TRIP REPORT: 71st ANNUAL MEETING
TRANSPORTATION RESEARCH BOARD
WASHINGTON, D.C., JANUARY 14 - 15, 1992

1. Sessions and Meetings Attended

1: Highway Deicing Chemicals and Weather Systems (first paper only)

45: Condition Surveys for Concrete Structures

88: Concrete Permeability

129: Repair and Rehabilitation of Concrete

A3C09: Winter Maintenance Committee

A3C15: Corrosion Committee

2. Reports Collected

i) J. Conrad and J. Spaid, "Experiments with Corrosion Inhibited Deicers in Washington State", Paper No. 920163

ii) E. J. Fleege, "Field Experience: Dry and Pre-Wetted Calcium Magnesium Acetate", Paper No. 920485

iii) R. J. Smith, D. W. Pfeifer, J. R. Landgren and D. McDonald, "Laboratory and Field Corrosion Test Methods for Highway Metals Exposed to Inhibited Rock Salt", Paper No. 920230.

iv) S. E. Boselly, "A Benefit-Cost Assessment of the Utility of Road Weather Information Systems for Snow and Ice Control", Paper No. 920600.

v) C. D. Buscemi and K. A. Hoenke, "Recent Research on Alternative Deicers at Chevron", Paper No. 920681.

vi) D. Whiting and T. M. Mitchell, "A History of the Rapid Chloride Permeability Test", Paper No. 920154.

vii) N. G. Thompson, D. R. Lankard and Y. P Virmani, "Improved Grouts for Bonded Tendons in Post-Tensioned Bridge Structures", Paper No. 920956.

viii) D. Bunke, "Ohio's Experiences with Rapid Permeability Testing".

ix) W. H. Hartt, "Cathodic Protection Utility for Corrosion Mitigation on Pretensioned Steel in Concrete", Paper No. 920820.

x) B. J. Smith, "Epoxy Injection of Bridge Deck Delamination", Paper No. 920392.

xi) T. Miller, "Benefit-Cost Analysis of Lane Marking," Paper No. 920297

xii) J. Ahern, C. A. Niedner and A. Barker, "Roadside Wildflower Meadows: A Summary of the Benefits and Guidelines to Successful Establishment and Management", Paper No. 920431.

xiii) NCHRP, Summary of Progress, December 31, 1991, Transportation Research Board.

3. **Notes**

i) Session 1: Highway Deicing Chemicals and Weather Systems

I was only able to hear the first presentation in Session 1, which began at 8:30 a.m. because of a conflict with the Corrosion Committee meeting which began at 9 a.m.

John Conrad described Washington State's experience with corrosion-inhibited deicers. Contrary to a recent letter in the Globe and Mail which stated that Washington does not use any salt, the state uses 7,000 - 8,000 tons per year. A bill to ban the use of salt was introduced in 1988 but was withdrawn after the DOT agreed to test alternatives. Most of the salt, and alternative chemicals, are used for frostproofing sand piles and to embed sand in the snow or ice surface. Some limited use is also made of neat chemicals for deicing. The state approves the following products CG-90, Freezgard + PCI, urea, CMA, Quiksalt + PCI and Ice Stop CI. All except urea and CMA are chloride-based deicers which cost more than twice the cost of road salt. Estimates of reduced corrosion rates are based on standard laboratory coupon tests which do not represent performance under field conditions. In earlier work, the use of calcium chloride was discontinued because it resulted in slippery road conditions. Sodium formate was found to cause very high corrosion rates, which agrees with MTO data on commercial sodium formate.

I collected copies of two of the other papers presented in the session. E. J. Fleege's paper describes Minnesota's experience with using potassium acetate to pre-wet CMA to improve retention on the highway. The tests were carried out in Duluth in the winter of 1990-91 and were visited by staff from Owen Sound District. Up to 10 percent by weight of potassium acetate was found to improve the adhesion of CMA to the roadway though at application speeds greater than 15 to 20 mph, bouncing of CMA off the pavement was still a problem.

S. E. Boselly's paper describes a benefit-cost assessment of RWIS technology for improving winter maintenance operations. The work was done under SHRP Contract H207. A complex statistical model was developed and used to predict the benefits of a number of strategies. A proactive response to detailed forecasts of road conditions provided the greatest benefit-cost ratio. This strategy requires that maintenance crews be mobilized before snow and ice-related problems develop and that crews not be deployed if not necessary (not a surprising conclusion!). A combination of forecasts, sensors and road thermography was predicted to reduce decision errors significantly while still having a benefit-cost ratio greater than one.

Also in Session 1, Tom Menzies presented the results of the NAS study on the "Comparative Costs of Rock Salt and Calcium Magnesium Acetate for Highway Deicing". I served on the committee charged with producing the report and have a copy of the published document (TRB Special Report 235) which was released at the conference. The conclusions do not differ substantially from the results of MTO work except that it emphasises local and selective use of CMA. The report expresses the view that the cost of CMA is unlikely to fall below the current cost of $600 to $700 per ton.

Of particular interest to MTO is a comprehensive chapter on the impact on road salt and drinking water. The EPA does not regulate sodium because of the minor contribution of drinking water to daily sodium intake (generally less than 5 percent). The data in this chapter should assist the Ministry in the equitable resolution claims for contaminated drinking water.

ii) Corrosion Committee

Two presentations were scheduled: one by Neal Burke of W. R. Grace and Co. on post-treatment of concrete with calcium nitrite and the other by John Broomfield reporting the status of the SHRP structures projects.

Calcium nitrite has been promoted for many years as a corrosion inhibitor which, when mixed in fresh concrete, prevents chloride-induced corrosion. The reasons it is not used by MTO are that it is expensive, the nitrite ions are consumed in the reaction with chloride ions, and the long-term effectiveness is not proven. W. R. Grace have investigated using calcium nitrite as an impregnant for hardened concrete. Three approaches were described: i) dry the concrete to 100°C at the level of the rebars (about 15 hours), cool slowly, pond a 15% calcium nitrite solution for 24 hours, remove excess solution; ii) Add 4% calcium nitrite to a latex coating and allow diffusion of the nitrite; iii) drill holes around a concrete patch and fill with grout containing 10% nitrite, as well as add 10% nitrite to the concrete patch. I have always recommended against using calcium nitrite as suggested in method iii) because calcium nitrite is an anodic inhibitor and a properly prepared patch is cathodic.

John Broomfield stated that Contract C-101 is now complete and the final reports and manuals will be published over the next six months. Manufacture and sale of the permeability meter developed by CTL is being investigated. In Contract C-102 which is actually seven contracts C-102A to G (I chair the expert task group for all the contracts), a report on the field performance of cathodic protection systems will be published soon. About 90% of 287 installations were reported to be "working", though some generic deficiencies were noted: conductive paints failed under wet conditions, slot systems popped out and overlay delamination occurred on cable and mesh systems. The work on cationic corrosion inhibitors began under Contract C-102C and transferred to C-102E has been terminated. Contract C-103 also includes work on corrosion inhibitors. Three commercial products, Alox901, Cortech and DCI are showing promise. The manual which will be the final product of Contract C-104 is now being portrayed as "The Joy of Bridge Repair"!

Frank Lisle (TRB staff) stated that TRB may have to limit the number of papers published or increase the number published as abridgements. There are now 178 committees and task forces in Division A and a sunset provision (likely 6 years) will probably be implemented. The new Surface Transportation Assistance Act will increase the funding for the National Cooperative Highway Research Program from $8M to $14M per year, a reflection of the value which the United States places on highway research.

The bombshell at the Corrosion Committee, if not the entire conference, was an unscheduled presentation by K. C. Clear on the effectiveness of epoxy-coated reinforcement (ECR). K. C. Clear has a long association with ECR, beginning with the development of the product at the National Bureau of Standards (now NIST) under FHWA contract research funds in the early 1970's. More recently he has investigated the performance of ECR under contracts with the Concrete Reinforcing Steel Institute, C-SHRP and NCHRP. Examples of unsatisfactory performance of ECR outside the Florida Keys are now coming to light (3 of the 4 documented cases are in Ontario). On the basis of the observed field performance and accelerated testing, Clear stated epoxy coated rebar technology is flawed and that bars coated to the current specifications will not assure adequate long term field performance in severe chloride environments especially those involving continuous or very frequent wetting of the concrete. A handout was distributed at the meeting and the information must now be considered to be in the public domain. At MTO, the examples of poor performance had been discussed by the Structure Durability Committee and a research project identified for FY 92/93. It was anticipated that the research being undertaken as part of other studies, particularly by C-SHRP and NCHRP, would reduce the MTO effort. The developments at TRB have increased the priority and level of effort which will be required by the R & D Branch. It is also important that the current information be shared with the Ontario industry as soon as possible (a meeting has been arranged for January 30).

iii) Session 45 Condition Surveys for Concrete Structures

The first presentation was made by J. C. Duke of VPI on the use of infrared thermography to detect delaminations in substructure elements. The work was undertaken as part of the SHRP Contract C-101. Artificial heat was applied to induce differences in the surface temperature of the concrete. Only an academic could conclude that "the method is feasible but that the practical constraints cannot be overcome"!

Gerry Clemena described the use of half cell potential measurements in condition surveys of bridge decks. He concluded, though not necessarily justified, that half cell measurements are not always effective and that a 4 ft. grid spacing is too large. A 1 ft. spacing was recommended but this is impractical for any work other than research studies. In another presentation on rate-of-corrosion measurements he reported data comparing the KCC, Nippon Steel and GECOR devices. Measured corrosion rates were highest with the KCC instrument and lowest with the GECOR, especially in the passive range.

Don Pfeifer of WJE Inc, described the development of a corrosion inhibitor for salt under a contract with Akzo Salt Inc. All the standard laboratory corrosion tests were completed and the product was tested on the Dan Ryan Expressway and Chicago Skyway during the winter of 1990-1. It was reported to reduce corrosion substantially. The inhibitor is proprietary and does not overcome any of the objections we have raised to the use of the other forms of corrosion-inhibited salt which are being promoted.

The final presentation was made by Charles Buscemi of Chevron on the corrosion rates of steels in CMA solutions. Much of the study was very theoretical and focused on the interpretation of potentiodynamic scans conducted in accordance with ASTM G5.

iv) Winter Maintenance Committee

The first part of the meeting was devoted to committee business. The committee is sponsoring a symposium in Minneapolis during the week of Sept. 14. Forty abstracts of papers have been received (including 2 from R & D), of which 21 are from North America, and 19 from Europe. There was concern that there was no involvement from Japan and no papers on economic implications. An attempt will be made to fill these gaps. The papers will be reviewed after the conference.

There was a short presentation by David Kimmel of Magnette University who is writing an NCHRP synthesis report titled "Managing Roadway Snow and Ice Operations." The scope is better suited to a textbook than a synthesis! Only the outline has been completed. A final draft is expected in late 1992.

There was also a short presentation on TRB Special Report 235 which was discussed under Session 1. David Minsk described the status of the Snow and Ice Contracts in SHRP. The major product to date has been the snowfence guide and video produced under Contract H-206. MTO has copies. There was a brief description of Contract H-208, Anti-Icing, being carried out by Mid-West Research Institute and Michigan Technological University. Various mixtures of sodium chloride, calcium chloride, CMA, urea, magnesium chloride and potassium acetate are being evaluated at a disused airfield in the Upper Peninsula of Michigan.

Wilfrid Nixon of the University of Iowa described his work on Contract H-204A - Ice Cutting. The project is examining ways of modifying snow plow blades to improve the ability to remove ice from pavements by mechanical means. Given the nature of the ice-pavement bond, I am not optimistic that the project will be successful.

v) Session 88 Concrete Permeability

This session was a pleasant surprise and proved to be much more interesting than I expected. David Whiting described the history of the rapid chloride permeability test. I had not realized that this test was originally intended as a field test. However, it was more practical to remove a core and use a standardized laboratory version of the test. The method correlates well, for ranking purposes, with standard ponding tests but round robin testing resulted in a coefficient of variation of up to 16%. The method has been rewritten as ASTM C1202 "Electrical Indication of Concrete's Ability to Resist Penetration by Chloride Ions" (title courtesy of Bryant Mather).

Neal Burke described the application of the rapid chloride permeability test to concretes containing microsilica and the need for more sensitivity when testing high quality concretes. Caroline Hanson of Queen's University showed data that indicated chloride diffusion is increased in specimens under tensile strain but the experiment was inconclusive because of the improper storage of specimens. Measurements of oxygen diffusion showed that oxygen flux is independent of concrete cover (which confirms work reported by Gjorv and his co-workers) but is reduced if chlorides are present. Dennis Bunke of Ohio DOT described the use of the rapid permeability test in a production laboratory and concluded that the test was valuable for comparing mix designs and admixtures. The data showed that the permeability of concrete made with shrinkage compensating cement was higher than latex-modified concrete which, in turn, was higher than silica fume concrete. This is interesting in view of a presentation made at the ACI meeting in Dallas during which a consultant for the Ohio Turnpike Authority was advocating the use of shrinkage compensating cement. Doug Hooton of the University of Toronto reported on a comparison of using several methods of measuring concrete permeability. He concluded that a number of tests can be used to measure relative performance instead of the standard high pressure water penetration test and that sorptivity using an alcohol drying procedure was the best alternative.

vi) Session 129 Repair and Rehabilitation of Concrete

This session started badly and deteriorated. Barbara Smith of Kansas DOT claimed that epoxy injection of delaminations at 3 to 4 year intervals was as effective as a concrete overlay. She had no information on costs. She also believed in "ghost" delaminations which appeared and disappeared. A similar phenomenon to tooth fairies I suppose. M. Sprinkel of VTRC described the use of high performance concrete for the rapid repair of bridge decks. In fairness, this was a reasonable paper. The mixes tested included an 8 bag mix of Pyrament cement at $13 per bag. Experience with this product has been mixed. Ron Purvis of Wilbur Smith and Associates described an ongoing assignment to write a NCHRP synthesis report on underwater repair of concrete elements. The presentation was amply illustrated with slides, none of which showed underwater repairs. The fourth presentation described bridge deck condition surveys in West Virginia. In 1972 it might have been relevant, in 1992 it wasn't.

vii) Other

a) I only spent two days at the conference because I took advantage of being in Washington to meet with K. C. Clear in my capacity as chairman of the project panels for the C-SHRP study "Effectiveness of Epoxy-Coated Reinforcing Steel" and NCHRP Project 10-37 "Performance of Epoxy-Coated Reinforcing Steel in Highway Bridges". K. C. Clear is the principal investigator for both contracts. Because of the privileged nature of project panels it is not appropriate to summarize the discussion in a public document. It was, however, a very useful day and what I learned will influence the Ministry's position with respect to epoxy-coated rebar. It also avoided a separate visit to Washington. The C-SHRP study will be completed by February 28, 1992. The NCHRP contract began May 1, 1991 and ends January 31, 1994.

b) Papers on pavement markings and wildflower plantings were acquired for A. Coomarasamy and N. P. Cain respectively.

c) It took two hours to check into the Sheraton Washington on Sunday afternoon. The manner in which guests were handled was disgraceful. Ministry delegates may want to bear this in mind when selecting a hotel in future. On my return trip I caught a non-stop flight from Dulles to Toronto operated as a Delta connection. This is a relatively new service which is good, and would be even better if the plane was larger than a 19 seat Beechcraft.

Dm

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235-3732

Trip Report TRB Annual Meeting 1992

The TRB Annual Meeting continues to grow in size. This year 1100 papers were presented at over 250 sessions with the same number of committee meetings proceeding simultaneously. There is continued concern in the USA that their research is lagging behind their competitors in the world market. Research funding for NCHRP is to be increased by 60% this year despite, or perhaps because of, the recession.

My focus was on 3 specific committee meetings and 3 sessions:

1) Committee A2F03 on Management of Quality Assurance.

At this committee I was seeking help with our problems in introducing hot mix end result specifications. Our contractors are designing mixes with 3 to 5% voids in theory, but in practice many mixes are at the 3% end of the range. They are able to meet the specification requirements for gradation and A.C. content but on the road we are finding only 2% voids, with the potential for flushing problems. When we try to correct the problems we experience disputes over the precision of the voids testing. One potential solution used in Virginia is to force the contractor to select a mix at the midpoint of the range at 4% voids. In practice this gives an extra 1% freedom of action on the road and generally reduces the problems. We will look at this option.

2) SHRP Research

I reviewed the proposed new approval and acceptance test methods for asphalt cement which were on display. The package of equipment and software will cost at least $100,000 for each laboratory. If the methods are adopted we would need one set up in each of our 5 regional laboratories. Our Bituminous Section is monitoring progress and no action is needed yet (technology information sheets are attached for Regional Geotechnical Engineers).

Another SHRP project of interest was the use of lithium based admixtures to reduce Alkali Silica Reaction. Long term testing is needed to confirm the effectiveness of this treatment. The technique is of limited application to us as we could not afford the manpower for the quality assurance involved, unless a good on-site test for admixture quantity is developed.

3) Safety of Bridge Falsework

I attended a session on this subject as we have had a number of partial falsework failures over the past 25 years. The examples given were all ones with which our designers and inspectors are familiar:

a) Omission of hardwood wedges where specified.
b) Badly designed prefabricated falsework towers and jacks.
c) Inadequate foundation design for temporary footings.

4) Committee A2D02 on Non-bituminous Components in Hot Mix

This is a very active committee and over 40 people were present. I presented information on our Waste Tire Demonstration Project and there was strong interest in this topic. Seven papers on the use of waste tires in hot mix were presented at a session organized by this committee. The mandatory use of tire rubber on federal highway projects will ensure that this interest continues. I have asked to join this committee as we need to keep up to date on this topic.

The other presentation at this committee meeting was on lead based anti-oxidants for hot mix. The speaker was from Australia. Kai Tam did some evaluation about 10 years ago which showed that these additives are not effective in Ontario's climate.

5) Committee A2E01 on Performance of Concrete

This committee is looking for Research Needs Statements in the field of linking test methods to actual concrete performance. I believe our present testing systems are working well but will discuss this issue with Hannah Schell.

6) Sessions on Prediction of Capacity and Defects in Drilled Shafts (Caissons) by Non-destructive Testing

I attended 2 sessions with 15 presentations on a major project at test sites in California and Texas where a number of companies used various NDT techniques to try to predict capacity or find prepositioned defects in large diameter bored piles.

Most techniques involved applying a force at the top of the pile and measuring its response. Others also use tubes prepositioned in the piles. The surface techniques only predicted major defects, such as 50% of the pile area being missing, with any accuracy. Multiple defects could only be predicted on those piles with prepositional tubes. The techniques which applied large forces to the top of the pile often caused damage to the pile.

The techniques seemed capable of comparing the capacities of similar piles under similar conditions but should not be used for predicting pile capacity without detailed soil data (an information sheet is attached for the Foundation Design Section).

TRB '92

Quality and Standards

R.S. Reel

Head

Bridge Management Section
Structural Office
235-5630

TRIP REPORT TRB - JANUARY 1992 - R. S. REEL

BRIDGE MANAGEMENT WORKSHOP - 1991 01 12

- AASHTO BMS Guidelines for the requirements of a minimum Bridge Management Section have just been published and will be available in about a month.

- Federal Legislation has mandated that each State must have a BMS in place by 1995 for all bridges, including municipal bridges.

The following network bridge management systems were presented.

1. **Pennsylvania's BMS - G. Hoffman and A. Bhajandas**

   - Has been operational since December 1986.
   - Developed under the guidance of an eleven man team made up of 7 in-house and 4 external experts, who met 3 days a week for 2-1/2 years.
   - Software development cost over 3 million.
   - Language PLI and Cobal.
   - Rating module expected to be developed in about a year at an additional cost of $1 million.
   - Future developments, GIS and integration with other systems.
   - System is based on level of service and bridge condition, not cost/benefit analysis.
   - Prioritizes maintenance and capital programs.
   - Predicts future needs based on deterioration rates derived from condition rating and load capacity.
   - Each District has one full-time BMS staff.

2. **North Carolina's BMS - J. Lee and D. Johnston**

   - Since 1985 based on level of service.
   - Cost/benefit analysis added as of 1991. Optimization done one year at a time.
   - Prioritizes maintenance and capital programs.
   - Deterioration rates based on condition ratings.
   - System optimizes budget allocation and forecast needs based on element condition and user needs.
   - Cost $300,000 over 10 years for university funding.
   - In-house costs not known.

3. **New York BMS - W. Winkler**

   - Legislation mandate to develop BMS.
   - In-house development started 1990 under a three level multi-disciplinary team.
   - Implementation 1992.
   - Individual models will be implemented as they are developed.
   - Uses dBASE 4.
   - Prioritization based on "ash can" approach. Bridges whose priorities are set due to condition, paving contract, etc. go into one can.
   - Ultimate system will include CADD and engineering design modules.
   - Expected cost $2.5 million.

4. Indiana's BMS - D. Woods

- Started 1990.
- 2 man in-house effort with Purdue University providing research.
- Incorporates regression equations for costs, Markov chain for bridge condition prediction, life cycle costing, bridge safety index and community impact index.
- Cost $200,000 for phase 1.
  $600,000 for implementation.

5. FWHA PONTIS BMS - R. Shepard

- Developed by Optima Inc. and Cambridge Systematics under Technical Advisory Committee made up of FWHA, TRB, California, Minnesota, North Carolina, Tennesee, Vermont and Washington States.
- Implementation testing completed by California in December 1991.
- Will be made available by FWHA to all States, free of charge, in about 3 months.
- Public domain software written in C language.
- Can be customized to the needs of each State.
- Uses cost/benefit analysis.
- Incorporates new rating system for bridge elements and probabilistic methods of prioritizing.
- Prioritize maintenance and capital programs.
- Forecasts future expenditures.
- Performs 'what if' calculations.
- We should get a copy of it and study how parts of it can be modified for our needs.

6. NCHRP 12-28(2)A - S. Lipkus

- Delcan, Toronto, has an 18 month contract to develop, test and produce documents for a BMS that can be used by the smaller States and municipalities, cost $390,000.
- PC based.
- Will use cost/benefit, life cycle and level of service.
- Deterministic methods of prioritizing.
- It will be simpler than PONTIS but since its development is just starting there is a possibility that most States will opt for PONTIS and not wait for NCHRP to develop theirs.

<u>Other Presentations Attended</u>

1. Evaluation of Infrared Thermography as a means for Detecting Delamination in Reinforced Concrete Bridge Substructure Elements - John Duke, J. Lee.

   SHRP Report
   Artificial heating and Durinal heating
   3 hour heating and cooling of column
   Daily heating cycle was not enough to conduct the test.
   Rejected as a viable method

2. Benefits of Using Half Cell Potential Measurements in Condition Surveys of Concrete Bridge Decks
G. Clemena, D. Jackson & G. Crawford

Usefulness uncertain, not always effective.
Grid spacing no larger than 2 feet recommended as 4 feet grid missed a number of delaminations.

3. Laboratory and Field Corrosion Test Methods for Highway Metals Exposed to Inhibited Rock Salt
R. Smith, D. Pfeifer

Wet/dry test much better than partial immersion.
Atmospheric corrosion is a large part of total corrosion.
Reductions of up to 60% to 70% in corrosion.
Proprietary product.

4. Use of Rebar Corrosion Rates in Condition Surveys of Concrete Bridge Decks - G. Clemena

3 LP device
3 LP > NSC > GECOR

Metal loss to delamination 3% to 6% on #5 bars.
Other studies less than this.
Corrosion rate fluctuates with temperature.
Corrosion rate depends on moisture content.

5. Performance Evaluation of Integral Abutment Bridges
Alan Soltani & Anant Kukreti

FWHA recommendation Steel 300'
Concrete 600'

All States use empirical data for length of integral bridges.

	Usually
Steel	200' to 300'
Concrete	300' to 400'
Prestressed	300' to 450'

Free draining backfill used by all.

<u>Disadvantages</u>

Field placement of fill and proper compaction.
Effects of elastic shortening.
Heavier wingwalls.
Adequate pressure relief joints.
Positive tie connection between approach slab and abutment.
Erosion of approach slabs.
Skew 20
Lack of rational methods.

Integral bridges performed better in earthquakes.

6. Long Term Serviceability of Isotropically Reinforced Bridge Deck Slab
S. Alampalli, G. Fu, F. Pezze

New York - 29 bridges built to empirical method based on Ontario approach
13 being studies
4 instrumented

Acceptable criteria
Maximum stress <allowable stresses
Crack distribution
Chain drag for delaminations

Bar spacing studied
#4 @ 8" x 8"
#4 @ 12" x 12"
AASHTO

Max. stress about 10 ksi after 2 years.
12 x 12 grid stress 10 < 12
8 x 8 grid stress 6 < 12

Transverse cracks	64%
Longitudinal cracks	32%
Diagonal cracks	4%

AASHTO decks comparable crack densities.
AASHTO decks have longitudinal cracks as well.
No delamination.
Design satisfactory.

7. Permeability Evaluation of Concrete Bridge Structures Exposed to Marine Environment in Florida
C. Meletion & M. Tia

No existing test methods for in-situ permeability tests.
Developed permeability prove, about 12" long, 3/4" dia.
Hydraulic pressure of 200' psi sufficient.
0.97 correlation with field data.
Can use prove for specification compliance.
Submitted for patent.
Price not known but guessed at $10,000.

8. Comparison of Treatment Methods involving Polymer Impregnation for Abating Corrosion in Overlaid Bridge Decks
T. Dutta, R. Weyers

SHRP project C-101
5 treatments LMC, LSDC
Polymer impregnation and combinations.
I_{corr} correlation 0.64
Insignificant difference between the 5 methods.

9. The status of the Nation's Highways and Bridges:
Conditions and Performance
Report of the Secretary of Transportation to the U.S. Congress
- Copy of Report picked up.

10. Data Requirements for National Transportation Policy Making

Special Report 239; Data for Decisions; Requirements for National Transportation Policy Making.
Available for $21.00 from T.R.B.

11. A Chloride Diffision Model for Thin Concrete Bridge Deck Overlays - P. Hoffman, R. Weyers

Apparent diffusion as a quantifiable method.
44 bridge decks in 7 States tested.
10 untreated, 16 LSDC, 10 LMC, 8 MSC, about 8 to 10 years old for LSDC & LMC, 2 years old for MSC, untreated 20 years old.

Diffusion Rates:
UT & LMC = 0.04 sq. in.
LSDC & SF = 0.02 sq. in.
Lowering diffusion by 1/2 doubles the life.

12. Field Performance of Low Slump Dense and LMO Overlap in North America.
W. Chamberlain, R. Weyers
C. 103, Text 1. Complete 1990

	Mean	SD
Based on perception LSDC and LMC	16.4	5.4

Failure Definition, Indicator Total Damage (Del + Spall + Patching)

Deck failure	40% of deck damaged
	2% spalled
Treatment failure	50% of applications

Conclusions

1. No difference in LMC & LSDC.
2. Mean Service Life 17.5 years curve line extrapolation
   31.7 " straight line extrapolation
3. Service life exceeds assumptions.
4. Service life unrelated to traffic volume and environmental factors in the first 15 years.
5. With extraordinary attention, service life may exceed 40 years. (Removal based on half cell survey).

13. 20 year Performance of IMC Overlays
M. Sprintel, Virginia

12 decks - 2 to 20 years old. Treated with LMC.
2 new decks - 16 years treated with PCC on 1 span, LMC on other (Control Structure). Based on 3 cores for each bridge.

14. Properties and Performances of Micro Silica Concrete in Bridge Deck Overlays
M. Luther, Elkem Materials Inc.

Improved impermeability.
1984 first application in overlays in Ohio.

15% SF, W/C 50.35 Typical 7 to 10% SF
Ternary Concrete: Cement + Ash + MS,
58 bridge overlays done with MS
5 full deck done
7 years good performance

15. A Simulation Approach & Prediction of Highway Structure Conditions
Yi Jiang, Indiana & K. Sinha, Purdue

1. Statistical Regression, give mean average values
2. Stochastic test, Markov chain, predicts average plus future condition of individual bridges.
Has some problems.

If 100 bridges with R(o) = 6 and transition 0.4 all will be 5, however, according to p = 0.4, 40% of bridges should remain 6 and 60% should go to 5. Probability based on age of bridges. To solve use Monte Carlo simulation. Monte Carlo gives better cost. Markov method better for individual bridges, not for all.

16. Network Bridge Deck Survey Using Highspeed Radar
K. Masee, A. Rawson

New Hampshire - 44 bridges surveyed with in-house equipment.
Going to survey all decks in 2 to 3 years.
Did 8 to 24 decks a day at 30 - 55 mph
chaser vehicle behind survey vehicle for protection
Comparison, Asphalt removed during rehab. for 19 decks
8 were new decks
Correlation $R^2 = 0.81$
Std. error 4.4% of deck area.
Categorization 93% correct.
Repeatability study with different operators and days after rain.
Good correlation.
Can do all 1000 bridges every 3 years.
Cost $500 to $200/deck.
Sample 18" width, looking at upper level of conc. only.
$150,000 to set up.

17. Vertical Bridge Rehabilitation: Concept, Design and Implementation
A. Shirole

Presented deterioration trends for the past 10 years.
Most of the deterioration is under the joints.
59 bridges programmed for repairs under joints.
$600,000,000/year for N.Y. bridge rehab.

18. New Innovative Technology in Computer - Automated Bridge Insp. Process
S. Kus, Florida, T. Davidson, DeLeuw Cather, L. Fij, California

Grid pad
Sony CED-TRS Handyam - video
35 mm digitized Camera
Voice Automated Audionic FM transceiver
Computer
Office equipment
486, laser printer, scanner
Whole system for less than $7,000.
Office time cut in half, field time same

A number of States are using Grid Pad or Scriptwriter.
5 or 6 similar systems will be on the market this year.
Note: Structural Office tested grid pad in 1991.

19. Assessment of Bridge Vulnerability to Hydraulic Failures
A. Shinole & M. Lofturs
Proactive

Failure Modes,	US	NYS
Hydraulic	59%	39
Overload	14%	22
Collision	10%	14
Steel details	3%	6
Concrete details	<1%	
Earthquakes	2%	
Other	12%	

Out of 7000 bridges
703 on flood watch
148 continual watch
546 intermediate watch
376 on post flood watch

Over 150 vulnerability reduction projects. System based on visual inspection only. Legislated that all bridges be assessed no more than 10 years apart.

20. Seismic Retrofitting of Rectangular Columns
Column Strengthening against shear.
Steel angles and rods
Steel jacket with 3 grout types.

External ties, column failed with external ties breaking at 4 time yield for 4" spacing. For 6" spacing failed at 2 time yield.
Steel jacket failed at 8 times yield.

21. A Proof Load Formula for Bridge Rating
G. Fu & J. Tong

Paper available.

22. Non-Destructive and Destructive Tests On a Decommissioned RC Slab Bridge and Associated Analytical Studies

3 span bridge

Failed after the equivalent of 22 truck loads, applied by rock anchors.
1983 Code - rating factor of 1
1989 Code - rating factor of 5.4
3D Finite element analysis
200 node modal analysis
Very useful test.

23. Epoxy Injection of Bridge Deck Delamination
B. Smith, Kansas D.O.T.

Ten year old bridges injected yearly - on some section every 2 to 4 years.

If injection started at 5% delamination and continued every 2 to 4 years, life of deck can be extended by 20 years.

24. Rapid Repair with High Performance Concrete
M. Sprinkel

Methods used
Repair, patch, rehab. or replace.
Pyzament bonded cement.
Type 3 cement for pavement patches.
Rapid set Latex MC
High cement mix
Additives $CaCL_2$ or Silica Fume

25. Underwater Repair of Concrete Bridge Elements
R. Purvis
Synthesis Report being prepared.

20% of DOT used in-house divers
60% by contract
25% no underwater repair

TRB '92

Quality and Standards

K.K. Tam

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235-3724

Trip Report
71st Annual TRB Conference
January, 1992

Prepared by: K.K. Tam

The main focus of this year's TRB meeting in the area of bituminous materials and pavements was on: (a) the exhibit of SHRP'S major achievements so far by contractors with displays of over 100 "products" developed for asphalt, concrete and structures, snow and ice control, highway operations and long-term pavement performance,

(b) technology transfer and implementation of SHRP's new developments on test methods and specifications. (It is crucial that we keep a close monitor on progress of SHRP's developemnts and dissemination of their information so that we can compare notes with),

(c) introduction of stone mastic asphalt (SMA) to the U.S. as a result of the 1990 European tour by a group of U.S. transportation officials. It appears that there is a great deal of urgency for the U.S. (and Canada) to catch up with the European highway technology.

An event worthy of noting in the area of asphalt is the newly established "TRB Distinguished Lectureship Award" to Professor Carl L. Monismith, the first recipient of this honor for his prominent work as a teacher, researcher and consultant to the asphalt pavement industry. This award reflects the importance placed on the subject of asphalt by the transportation industry through TRB.

In addition to presenting a paper at Session 4B, I attended the different committee meetings and sessions. The following are notes taken at the meetings:

Session 4B - Pavement Performance During Freezing and Thawing

(*) E.C. Novak Jr. and E. DeFrain Jr., **"Seasonal Changes in the Longitudinal Profile of Pavements Subject to Frost Action".**

~ The authors suggested that greater use of data gathered from the increasingly more propular profilometer testing should be made for determining causes of deterioation, in addition to just for pavement roughnesses. He presented several projects to illustrate how data can be used to determine causes of surface roughness prior to repair and rehabilitation resulting in improvement in ride quality. He confirmed the general belief that pavements that are frost susceptible are rougher in the winter than in the summer (e.g IRI = 268"/mile versus 102"/mile respectively). However, more importantly, he found that the reverse is true for pavements that are not frost susceptible (e.g. IRI = 77"/mile versus 112"/mile). They will soon be switching over to the laser type of profilometer.

(*) K.K. Tam, P. Joseph and D.F. Lynch, **"Five-year Experience on Lowtemperature Performance of Recycle Hot Mix"**

~ The paper describes Ontario's experience on the low temperature cracking of early recycled hot mixes (RHM), and on laboratory investigation based on McLeod's limiting stiffness approach and the fracture temperature method. Results indicated that RHM are more susceptible to low temperature cracking than conventional mix, and that fracture temperature method is a better method for evaluating low temperature cracking potential of hot mixes than limiting stiffness method. Recommendations were made to ensure suitability of mix designed for expected winter temperatures.

Note: (*) = preprint available form K.K. Tam

Session 7 - SHRP - Implementing Asphalt Research Products

* D. Kulash, **"SHRP's Asphalt Products: What They Are and Why They Are Needed"**

~ D. Kulash updated progress on SHRP. Performance based specifications for asphalt cement are being developed based on new test apparatus and procedures and studies of 30 A.C. reference samples (out of 120 cruel oils). New computerized mix design procedure is being developed which will consider site specifics, traffic and risks. Asphalt mixture testing in the French studies indicated that GTM results have better resemblance of field compaction. Shear strength has shown to be closely related to rutting performance by studies carried out by different jurisdictions (Ontario mentioned). He discussed his European tour experience. It has been shown that there are better ways of building roads in Europe for over 20 years and much of their experiences could be transferred to the U.S..

* T. Larson, **"FHWA Steps to Encourage Rapid Adoption of New Performance-Based Techniques for Asphalt Pavements"**

~ He recalled that exactly 10 years ago he presented a draft plan on SHRP in TRB meeting, and that it is a long time coming to the present stage. He cautioned on the expectation on implementation and expressed Congress's concern with the state of highways. Congress is waching if the $150 m spent gave results and deliverables. $180 m will kick in after March 1993 to support LTPP when present SHRP ends. He outlined implementation process through TRB and AASHTO etc..

* R. Chamberland, **"AASHTO Actions to Get SHRP's Asphalt Products into Useful Specifications and Common Practice"**

~ He stressed that SHRP will sustain with full commitment from AASHTO through provisions in the organization to implement SHRP products. Communication between all parties and sensitivity of seniors in all highway agencies to new ideas cannot be overstressed if implementation is to be sucessful. He proposed the creation of a committee by senior or CEO and chief engineers to pick up and run with the products.

Session 38 - Flexible Pavement Construction: Materials and Rehabilitation

(*) J. Murfee and C. W. Manzione, **"Construction of Rut Resistance Asphalt Mixtures"**

~ A study was made to evaluate the difference in performance between mixes designed to Marshall versus gyratory procedures, under higher pressures fighter aircraft tires of 250 - 310 psi. Premature plastic failure of the Marshall mixes was observed while gyratory mixes remained stable. The study validated that the design process can assure resistance to rutting of asphalt mixes by simulating the compaction of aircraft in the laboratory with the gyratory testing machine. It was found that the granular layers contributed about two-thirds of the total surface rutting in all the flexible pavement test sections.

Note: (*) = preprint available form K.K. Tam

Session 52 - Flexible Pavement Design, Part 1

(*) K. Majidzadeh and S. Mesarovic, **"A Constitutive Model for Asphalt Concrete: Application to Rutting"**

~ A mechanistic visco-elastic-plastic model was developed for prediction of rutting in asphalt pavements. The model was based on finite element, and while in general agreement with experimental, results show that it does need more work and improvements.

(*) S. H. Carpenter, **"Load Equivalent Factors and Rutting Rates: The AASHTO Road Test"**

~ The paper described the development of the layer structural coefficient from data collected at the AASHTO Road Test conducted in 1960. As well, the 1986 revisions of the AASHTO pavement design procedure suggested that elastic modulus values are the preferred structural property for all materials to be used for determining layer equivalency factors/coefficients. However, the approach of relating the coefficients to contributions of materials to different distresses, particularly with rutting, could be considered over simplistic. Serious under-predictions of traffic required to reach a terminal level of rutting will result if current AASHTO LEFs are used for rutting comparison. He set out to develope a model which can describe general rutting based on characterization of permanant strain and rut depth with number of repeated axle loadings. The analysis can be used for determining performance indicators of current and new mixes which are different from those used in the original AASHTO road test.

(*) R.P. Elliot, **"Selection of Subgrade Modulus for AASHTO Flexible Pavement Design"**

~ The author examined the recommended resilient modulus value of 3,000 psi used in the AASHTO flexible pavement design equation, by comparing laboratory values on tests conducted unconfined using a deviator stress of 6 psi, with backcalculated modulus values from cohesive soils. He found that, in order to be consistent with the AASHTO Guide, backcalculated values must be multiplied by a factor of no greater than 0.33. For non-cohesive soils, it is not clear as what test conditions and adjustment factors should be used because AASHTO did not use granular soils in the test, i.e. further study needed.

Session 99 - Asphalt-Aggregate Mixture Analysis System

* H.L. Von Quintus, **"The NCHRP AAMAS"**

~ The NCHRP system is outlined in a manual consisting of guildlines for (a) selection of mixture components, (b) mixture design, (c) mixture analyses, (d) mixture performance evaluation. Currently, AAMAS is for designing and checking specific mixtures for resistance to various forms of distress, e.g. fracture, shear and deformation. However, the ultimate aim, when fully developed and correlerated with field performance, will be to optimize the structural and mixture design process to produce the desired pavement performance at least cost. Also, it is the aim of AAMAS to correlate existing design methods, such as Marshall, Hveem and other performance related methods to distresses (fatigue, rutting, moisture damage and thermal cracking). Detailed studies have been made to verify criteria for mix compaction, production, laboratory test conditions and traffic desification. Moisture damage criteria are set at TSR, MSR and FSR > 0.8 while other ravelling and skid resistance factors are considered as secondary in designs by the AAMAS.

Note: (*) = preprint available form K.K. Tam

* T.W. Kennedy, **"SHRP Progress Toward A Performance-Based Asphalt-Aggregate Mixture Specification"**

~ The speaker oulined the progress made so far by SHRP towards a performance based asphalt mix specification incorporating the used of computer in the process. The specifications will be quite specific covering N. American conditions, including Canada, on environment, temperature, precipitation and traffic. The risk factors are also recommended and the value will increase with increase traffic and severe environment. Aggregate gradations will be based on the 0.45 power curve with humps at around the # 16 seive for aggregate with one or two crushed face. Volumetric design based on air voids, VMA, VFA and filler/AC ratio system will be used. Effective VMA will be tied to 3, 4 and 5 % air voids. It is anticipated that fatigue test will be replaced by other factors such as energy dissipation, and low temperature prediction will only be tested on the binder. Full recommendation will be made on April 1st, 1992, including possible use of the GTM for field control testing and more aggregate tests.

* R.J. Cominsky, **"SHRP Progress Toward A Performance-Based Asphalt Mixture Design and Analysis System".**

~ An acronym MIDAS is used by SHRP for the design system. The speaker outlined the framework for the system consisting aggregate selection by screening tests for moisture and net absorption of AC - mainly paper work. After age and moisture conditioning, comparison testing by GTM, kneading, rolling wheel and rotating base Marshall was made. GTM was set at 1°, 6 rpm, VP of 0.6 MPa (86 psi) for 4" or 6" specimen which were compacted to 70, 90, and 100 rev for low, medium and high traffic volume sites, respectively. The slope density to revolution curve was drawn for evaluation. Confined compression test was done for rutting, and fracture temperature test based on a 10°C/hr drop in temperature was used (same as the test we use), in addition to the tensile creep test using an assumed Poisson's ratio for predicting cracking.

* D.N. Little, **"Selection of a Compaction Method for a Mixture Design and Analysis System".**

~ Five projects with various rolling patterns and air voids were compared with 5 different types of laboratory compaction techniques (Marshall, Arizona kneading compactor, Califonia kneading compactor, Texas GTM and steel wheeled compactor). It is major concern to find that density varied considerably depending on mode of compaction. Statistical analysis on the material standard deviation error of [$MSE = (X - V)^2 + S^2$] and

$$\partial MP = \sum_{i=1}^{MP} \left[\frac{[MPc - MPs]}{MP/NP} \right]_i$$

gave the following rankings:

Compactor	Project	Mix Prop.	Temp.
Ar. Kn.	5.0	4.8	4.7
Cal. Kn.	2.0	2.0	2.0
Marshall	4.0	7.5	3.3
St. Wheel	1.7	2.8	2.0
Texas GTM	1.0	1.5	1.3

It was shown that the GTM gives the lowest error for all three categories followed by the steel wheeled and Califonia kneading compactor.

Note: (*) = preprint available form K.K. Tam

* G.A. Huber, **"Field Control Methods and Procedures to Support a Mixture Design and Analysis System"**

~ A MIDAS database will be set up to record different components of mix designs and construction data with the aim to establish a control test softwares that provide continuous monitoring and test data sheets, control charts and statistical analysis. The GTM will be used as field control test, using a 1°, 6 rpm, VP of 0.6 MPa (86 psi) to max. field density. These software control tools are not, at this point, intended for the QA or QC payment purposes by agencies, contractors and consultants; they are just for % AC and gradation proportioning control which can be of volumetric if laboratory versus field results (e.g. air voids, VMA, VFA etc.) were known. As well, the engineering properties (permanent deformation, fatigue and low temperature) of field mixes can be determined and be part of the performance based specification.

* S. Brown, **"Asphalt Mix Design and Testing - A European Perspective"**

~ The speaker outlined the European mix type, current practice, EEC/European normalization, towards performance based spec., asphalt mixtures (SMA, pourous asphalt, modified binders etc.), laboratory equipment, innovative contracting and research. There are generally fewer A.C. sources and suppliers available, and greater concern on skid resistance (i.e. increase use of good aggregates) and less litigation in Europe. Currently most mix designs are by Marshall, except France where more sophisticated end-product approach is adopted. France uses the direct compression, WTM and trapezoidal stiffness tests. U.K. and Germany are still using the recepe type of specifications while Belgium has similar framework as the U.S.. European new asphalt standards will include WTM, indirect tensile strength and stiffness. With the objective of normalization of standards, the European Community Development Committee (CEN TC227) on Construction Materials for Roads and Airfields has been set up.

* M.S. Mamlouk and P.P. Khanal, **"Arizona Experience with AAMAS Procedure"**

~ Arizona evaluated the recent published NCHRP methods of mix design - 24 specimens required, 3 conditioning methods, 6 tests and took 11 days. Diametral and axial tests, and two compaction methods (Marshall and Kneading) were tried. AASHTO structural coefficient of 0.42 was found to be very close to what ADOT's 0.44 value used. Generally, ADOT's mix satisfied most of the test criteria.

Session 187 - Alternative Asphalt Mixtures to Resist Permanent Deformation

* P.A.F. Bellin, **"State of the art: Use of Stone Mastic Asphalt in Germany"**

~ Stone mastic asphalt (SMA) was developed in Germany in the mid-1960's under the name of "Splittmastic". It is a heavy duty mix and considered to be European's answer to rutting. It is based on stone-on-stone concept, and contains gapgraded crushed aggregate with about 80 % of plus #10 material of maximum size 5/8 in or 1/2 in. The AC content is relatively high of 7±1%, therefore the bitumen is modified with mineral filler or cellulose fibers to prevent binder drainage. Centre feed for drum or silo/screw feed for batch plants is needed for introducing the fiber to the mix during mixing. Due to the possibility of binder drainage, hot storage should be discouraged and overnight storage should not be allowed. For compaction, rollers must keep very close to the paver; no rubber tired rollers are allowed, and no vibration in the steel drum roller is necessary. Given the long term effectiveness in combating rutting, the increase in the up-front/construction cost of about 20 -30% is considered worthwhile investment by the German.

Note: (*) = preprint available form K.K. Tam

* O.W. Schutz, **"Use of Stone Mastic Asphalt in Germany"**

~ The speaker presented the view of a contractor. In Germany, contractors design, control and give warranty of mix constructed. Mix designs are more based on experience and Marshall is used merely as a tool to obtain optimun AC content. Asphalt cement contents range from 6.5% - 6.8%, 6.5% -7.0% and 7.0% - 7.2% for maximum size mixes of 11, 8 and 6 mm, respectively. Most commonly used additive in Germany is cellulose fiber (about 80%), followed by mineral fiber (56%), 10% polymer and 6% silica sand. He confirmed the 20% higher cost due to lower production rate.

(*) J.P. Serfass and J. Samanos, **"Stone Mastic Asphalt for Very Thin Wearing Course"**

~ In France, SMA are used extensively for surface maintenance and rehabilitation, occassionaly for new construction. SMA are used in very thin layers (25mm) with heavy tack coating (emulsion rates ranging from 500 g/m^2 on smooth to 900g/m^2 on pourous surfaces) to ensure good bonding and impermeability. Construction of SMA requires the normal good practice of laying asphalt with a few special precautions such as keeping roller tight against the paver and avoid excessive handwork etc. Performance of SMA is very good with longer lasting noise and friction characteristics similar to good open graded friction courses. Fibers such as "Chrysotile", "rockwool", glass and cellulose have been used (length from 0.25 to 1.5 mm).

* J. Bukowski, **"Stone Mastic Asphalt Practic in the U.S."**

~ SMA trails have been placed in a number of states including Michigan (M-52), Wisconsin (I-94), Georgia (I-86) and Missouri (I-70). Mixes followed closely to European gradations and cellulose fiber and "Arbocel" fiber were used. Binder drainage was observed in the Milwauke trail. A model specification for SMA is to be developed after data collection from as many states as possible is completed at the end of 1992. Cost increase of 100% was experienced, but a 25 - 30% premium is expected when it becomes a normal contruction process.

~ There were seven other speakers presenting their experiences with the SMA in their jurisdictions or testing in their laboratory. Generally, their information was very much the same as what have been mentioned above by the speakers.

Session 216 - Use of Waste and By-products in the Highway System

* J.J. Murphy, **"Waste Materials and Recycling Policy Issues: New York DOT Experience"**

~ N.Y. state handles 21 types of wastes everyday. President Bush's executive order on recycling rubber in hot mix by 1993 has accelerated the push for state jobs to include rubber in construction as an option. N.Y. put down various rubber mix designs in 1989 using the dry process, and it is found that social benefits outweigh extra construction costs. State agencies feel that they are being imposed on by legislatures. So far, problems experienced with implementing waste management have been more to do with institution obstacles for change. However, the speaker stressed that it vital to have a clear policy on use of waste and that cross check with current information should be maintained. P.R. work to get a clear message to the public is important. Life cycle cost should be carefully considered and sucesses will make the difference in the effort to recycling of waste in general.

Note: (*) = preprint available form K.K. Tam

* R.J. Collins, **"Availability and Uses of Waste and By-Products"**

~ NCHRP is to produce a draft report (#20 - 5) on use of waste and by-products in March 92. In addition to the technicalities, this report will address the major issues of environment as a result of using waste. Other issues on mandatory recycling by legislation, long term liability, indemnity by producers of products and recyclability were also discussed. The speaker stressed the important task of recycling household waste which constitutes some 75% of landfill waste. Municipal incinerator ash is not recommended for use in asphalt surface courses. Fly ash was found to perform well in embankment, base and subbase. So far, there are 42 states using RAP in hot mix, 42 states using fly ash, and 40 states conducting trials on rubber tires. As well, 42 states are mandatory to treat/use waste while half of those states have found ways to use the waste and have landfill problem. The speaker voiced his frustration by saying that "regulatory people speak different language and read different book". There seems to be an urgent need to have a common front and improvement on communication between all parties. Min DOT has tried 2 -3% incinerator dust in hot mix but had to take out indemnity for the public. By classifying all these resources as waste has created an image problem; the public view wastes as hazardous materials and subjected to more stringent requirements.

(*) L.L. Smith and R.M. Ramer, **"Recycled Plastics for Highway Agencies"**

~ Fl DOT studied the use of recycled plastic wastes for fence line posts and guardrail posts as mandated by a 1988 state law. All test work focused on data acquisition for selected essential properties and characteristics including durability, resistance to insects, soil microorganisms, environmental exposure, water absorption and flexural and tensile strength. Large diameter (7.5") posts showed major variations in composition and properties while small diameter (3.5") posts showed warpage under exposure tests. Some posts were stronger than concrete and possible candidates for guardrail posts.

*J.D. Brock, **"Economics of Using By-Products in the Production of Hot Mix Asphalt"**

~ In the U.S., it has been estimated that 12 - 14 billion tons of wastes are generated every year. The speaker stressed that the need for recycling is very much driven by economics. Since there are 40,000 asphalt mixing plants in the U.S., any gains or losses will be substantial because of the multiplying effect. It costs $3/ton to process concrete, $0.5/ton to handle fly ash, $1/ton to mill and $3/ton to process RAP. A total cost for producing a ton of hot mix is $15.70; the breakdown is: depreciation - $1, maintenance - $0.60, lab. - $0.50, drying $2.00, hot oil heater - $0.25, electrical power - $0.35, labor - $0.30, aggregate - $4.70, AC - $6.00. He used a hyperthetical example to show that recycling waste in asphalt can be benefitial.

Session 233 - Improved Methods for Evaluating Asphalt Mixture Sensitivity

(*) D.J. Elton and C.H. Juang, **"Expert System for Hot Mix Asphalt Concrete Design".**

~ Expert systems are computer programs that emulate the reasoning experts use in solving complex engineering problems. The authors developed a system called "HOTMIX!' for assisting designers in designing mixes, making laboratory samples and evaluating results. The program will provide specific advice on improving a mix in order to meet mix design requirements. The system evolves around Asphalt Institute Marshall mix design procedure. Although the emergence of expert system is relatively recent, it could be a very useful tool in assisting mix designers lacking experience.

Note: (*) = preprint available form K.K. Tam

(*) T.F. Fwa and S.A. Tan, **"Laboratory Density Measurements of Bituminous Mixes by Gamma-ray Probe"**

~ The feasibility of applying a twin-probe gamma-ray gage for measuring densities of asphalt mixes was evaluated. Three different types of mixes were examined, viz. dense and open graded and sand mix. It was found that better precision and accuracy were achieved with dense mixes than open mixes because of the uniform distribution of density within the mass (precisions were 0.35, 0.87 and 1.7% for sand, dense and open mixes respectively). Good correlation was obtained when compared results with those determined according to the ASTM method. However, the catch is that it costs $20,000!

(*) P.S. Kandhal and M.A. Khatri, **"Improved Rice Method for Determining Theoretical Maximum Specific Gravity of Asphalt Paving Mixtures".**

~ The repeatability and reproducibility of the Rice method has been considered unsatifactory especially when highly absorptive aggregates are used in the mixture. The authors set out to investigate the test variables involved and to improve on the test method. Two dense graded mixtures - one with low and one high absorption aggregates, with AC - 20 were used in the study. Three factors (temperature, residual pressure and vacuuming time) were investigated at three levels each, involving 108 tests. Based on the test results, optimum levels are recommended for temperature (77°F), residual pressure (30 mm Hg) and vacuuming time (15 minutes.). Use of these optimum levels will improve the Rice method. (I will discuss with Dan re.investigating this.)

(*) M. Stroup-Gardiner and J.A. Epps, **"Laboratory Tests for Assessing Moisture Damage of Asphalt Concrete Mixtures".**

~ As part of the field study made in the mid-1980's in four states, involving 13 test sections on various methods of adding lime in asphalt mixes, this study aimed at comparing different moisture conditioning prosedures with reported pavement condition surveys. Three conditioning procedures were evaluated: (1) no saturation, (2) partial, and (3) full saturation. It was found that the "no saturation" option provides the best agreement in relative ranking between conditioned resilient moduli values and the moduli values obtained for the cores. Also, there is little difference in the mixture properties obtained for a given aggregate source when lime is introduced to either dry or pre-wet aggregate during preparation of laboratory samples. This corresponds to the observations made for field mixtures that little different is noticed between introducing lime to pre-wet aggregate or lime with binder in the drum mixer.

* ***Committee A2D04 - Characteristics of Bituminous-Aggregate Combinations to Meet Structural Requirements"***

~ F. Hejl who looks after the TRB Bituminous Section mentioned that there are 268 sessions in this year's TRB meeting. This is over-saturated with papers (about 1,100, some 20% or more are bituminous related) and TRB would aim at keeping a maximum of 250 sessions next year.

~ There will a lot of interaction between SHRP and this committee during course of the coming months. By Oct. this year, many final contract reports will be submited to SHRP for review and members of this committee will be very helpful in this regard. A first draft of recommendations on mixture testing will be submited to the SHRP Executive committee Feb.'92. Three presentations were made during the committee meeting on progress of SHRP projects (A-005) on validating the relationship of AC and mixtures with performance models developed and contract (A-002A) on fatigue, fracture and creep compliance tests

Note: (*) = preprint available form K.K. Tam

* ***Committee A2D03 - Characteristics of Bituminous-Aggregate Combinations to Meet Surface Requirements"***

~ Included in the committee agenda were TRB announcements of Prof. Len Wood's retirement as Chairperson of TRB's Bituminous Section and other staff changes. House keeping business included reporting by different subcommittee chairpersons on their respective tasks. In 1993, session papers will be on the successes and failures of friction courses and on micro-surfacings, a joint session with another committee. J. Emery made a presentation on the Ontario's experience with use of SMA.

* ***SHRP Technology Transfer Exhibition - Asphalt***

~ New SHRP asphalt test equipment were on show in the TRB exhibits. They were mainly binder testing equipment and related computer soft and hardwares, viz. Bending Beam Rheometer, Dynamic Shear Rheometer, Direct tension Test Device and Presure Aging Vessel (I have the information sheets which explain more in detail). The only mixture test equipment on show was the resilient modulus machine . Because of transportation, the "Universal Test Equipment" developed by SHRP A-003 contractor was not at the exhibit. The total cost for implementation package on asphalt mixture and binder testing would likely be about $350,000 of which $100,000 would be for the binder tests. Also highlighted in the exhibit was the nation wide study on use of all types of proprietory cold mixes for pavement patching.

Note: (*) = preprint available form K.K. Tam

TRB '92

Quality and Standards

A.A. Mufti

Professor of Civil Engineering

Technical University of Nova Scotia
(currently on Sabbatical Leave and working with
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235-4653

TRB ANNUAL MEETING, 1992

Trip Report (pertaining to Advanced Composite Materials)

By

Aftab A. Mufti
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Technical University of Nova Scotia
(currently on Sabbatical Leave and working with
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The TRB Committee A2CO7 organized two events. In the morning of January 15, 1992 from 9:00 A.M. to noon, a committee meeting was held. Four short presentations were given by D.S. Barno of the Society for Plastic Industries, Richard Dauksys of BASF, Robert Austin of University of Texas and Dr. Srini Iyer of the University South Dakota. Dr. Iyer discussed the construction of an advanced composite prestressed concrete bridge. The concrete bridge deck of the slab-on-girder bridge was prestressed transversely in three sections. The first section was prestressed with the glass fibre reinforced plastic (GFRP) tendons, the second section was prestressed with the carbon fibre reinforced plastic (CFRP) tendons and the third section was prestressed with the steel tendons. The prestressing was applied at 4 inch centres at the top and bottom of the deck. The bridge is being monitored on site. Robert Austin gave the status of study on connections for pultruded shapes followed by Richard Dauksys updating the committee on the use of carbon fibre prestressing for the Ludwigshafen bridge in Germany. Lastly, D.S. Barno discussed the Society for Plastics Industries' involvement in manufacturing of structural composites. The presentations were

followed by discussions of other fibre reinforced concrete (FRC) and fibre reinforced plastic (FRP) research and development activities.

The Canadian delegates Drs. Abdel-Sayed, Rizkalla and Mufti described the activities of the Advanced Composite Materials Committee of CSCE. The publication of the-state-of-the-art report on the Advanced Composite Materials with application to bridges and the forthcoming visit of the CSCE'S mission to study the-state-of-the-art of Japan technology. Dr. Rizkalla described the research work on the FRP connections being carried out at the University of Manitoba and Dr. G. Abdel-Sayed discussed the precast, externally FRP prestressed T-beams with FRC deck being developed at the University of Windsor. Dr. Mufti presented the work jointly carried out by MTO and TUNS on the fibre reinforced concrete bridge decks with no internal reinforcements. The successful experimental work on the half scale FRC concrete deck-on-the-girder model has led to the decision to build on an experimental basis the proposed deck on a rehabilitated bridge in Ontario. This is to be accomplished in summer of 1992.

In the afternoon of January 15, 1992, a session sponsored by the committee was attended by about 50 engineers and scientist. Six presentation were made. The first presentation by Drs. R. Sen and Dr. M. Shahawy from Florida discussed the feasibility of GFRP pretensioned piles in a marine environment. Their

conclusion was that the unprotected GFRP tendons in a marine environment were not suitable. The second presentation was by Prof. Urs. Meier from Switzerland. Prof. Meier discussed strengthening of girders with graphite plates. The technique developed at the Swiss Federal Laboratories (EMPA) was applied to the repair of the Ibach bridge, which crosses the small river, near the city of Lucerne. An important prestressing tendon of the bridge had accidentally been damaged during maintenance work on the bridge. The damaged bridge was strengthened by glueing 2 mm thick and 150 mm wide CFRP laminate. It was pointed out that the repair work was simple and that the bridge remained open to traffic during the entire repair work. Dr. Lawrence Bank on behalf of the Catholic university and the university of New Hampshire described full scale testing of Grid and Grating FRP reinforced concrete bridge decks. The bridge deck was modelled as a simply supported plate without any girders. Not surprisingly, the failure of the deck was in flexure. It was claimed that placing of the grating is so easy that much of the labour costs will be reduced. However, it seems that the fibre reinforced concrete bridge deck-on-girders without internal reinforcement developed jointly by MTO and TUNS is much more attractive. In this system there is no internal rein-forcement to be arranged before concreting thus eliminating labour costs and corrosion problems. Further, the deck reinforced with only the FRP grating failed in bending indicating that this slab is much inferior in load carrying capacity to the conventional reinforced concrete slab

which failed in punching shear. Presentation by Dr. Tony Nanni of Penn State described the present status of the Japanese construction companies and their research and development work with the use of aramid prestressing systems for concrete structures. One of the conclusion reached by Dr. Nanni is that the Japanese construction companies are well advanced of the North American Construction companies in use of the Advanced Composite Materials. The North American Construction companies have no expertise in the Advanced Industrial Materials because of the lack of R & D. The last two presentations dealt with strengthening bridge columns with composites by Stuart Watson and Evaluation of a modular GFRP bridge Deck with acoustic emission by Joseph Plecnik.

In conclusion, it can be noted that the R&D and field use of the advanced composite materials in bridges and structures in USA and Canada is increasing.

TRB '92

Planning

J.R. Billing

Head

Commercial Vehicle Section
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235-5010

Session 13 : Truck Accident Countermeasures and Safety

The first three papers in this session were by the same group, addressing various aspects of correlation of truck inspection out-of-service criteria with other factors.

Michael Lentz and Tom Corsi examined the "Relationship between Motor Carrier Out-of-service Performance and Safety Compliance Review Ratings". This statistical study attempted correlation of these factors, to determine whether the two might be substitutes so that one would be redundant. It was done on the basis of fleet size, with fleets divided into five size ranges. They found that larger fleets have fewer trucks put out of service, and that the number of violations per truck also decreased with fleet size. They also found that the three middle sized fleets had a statistically significant correlation between their safety rating (unsatisfactory, conditional or satisfactory) and their out-of-service performance. However the correlation was not strong enough that the two measures could be regarded as substitutes. They could not say how this performance related to accidents, but they did suggest that grounding one truck in a small fleet could really improve that fleets accident rate, so some statistics could be a little misleading, and fleet size needs to be properly controlled in this work. They did suggest a large fleet with a high out-of-service rate indicates a poor attitude on the part of the fleet. They did agree with questions that other factors, such as fleet composition and commodity type may also be important factors, and that global statistical methods did not deal satisfactorily with very small operators.

John Douglas looked at the "Relative Efficiency of Out-of-service Criteria as Accident Deterrents", by evaluating how the inspection time shares and values related to crash shares and values by inspection category. He found that brakes, lights and steering tended to be over-inspected, and wheels, fuel system and suspension tended to be under-inspected, compared to their accident responsibility. Discussion suggested that the fuel system element was misleading, as fires are usually a consequence of accidents, not the cause. Discarding this and other minor factors, he concluded that brakes, wheels, suspension and steering are under-inspected. He suggested that the low-return inspection items should be discarded and the time saved should be used to inspect more trucks.

Michael Lentz looked at "Motor Carrier Accident Reduction due to Out-of-service Criteria", by examining accident rates in the first and third years of the MCSAP program. He found that accident rates diminished mildly, but truck defect rates diminished more. Discussion suggested this should be reasonable, as more and better inspections are now done, and equipment standards are a minor factor in truck accidents compared to driver factors.

Shaw-Pin Miaou discussed the "Relationship between Truck Accidents and Highway Geometric Design". The study developed a model that could be used to assess the change in truck accident rates as a consequence in changes in highway geometric design. He found that a Poisson regression model fit the data better than a linear regression model, because accidents are discrete, sporadic and probabilistic, and most road sections have no accidents. He found strong correlations between accidents and AADT per lane, horizontal curvature and grade, and weak correlation with shoulder width. The model did not account for speed or speed limit, nor did it take account of important factors like discontinuity of curvature or improper superelevation development on curves.

David Harkey gave an excellent presentation on the "Operational Effects of Wider Trucks on Narrow Roadways". They looked at how trucks interacted with the edge of

pavement, which relates to run-off-the-road accidents, and with the centre-line, which relates to sideswipe accidents, by following trucks and photographing and video-taping their progress on narrow two-lane roads in Arkansas. The comparison was between 96" and 102" wide trailers, as a function of various roadway parameters. They found that 102" wide trailers were about 10% more likely to encroach the edge line, or be within 1.75 ft of the centre line, and that 102" wide trucks operated on average 2.5" closer to the centre-line. The study did not look at accidents, but a subjective assessment would suggest that drivers use any space available when there is no other traffic, and take great care of their space when meeting an opposing truck. He suggested that two-lane two-way roads should have 12-foot lanes and at least 3-foot shoulders; that where a road has an accident history, it should either be upgraded or 102" wide trucks should be prohibited; and steps should be taken to improve driver performance.

Y. Shah spoke on "Traffic Accident Models for Interstates and Two-lane Rural Roads". This statistical study identified lane width, shoulder width, paved shoulder width, curvature and grade as important factors in accidents. It suggested curvature > 2.5 deg with grade > 3% on freeways, and curvature > 6 deg and narrow shoulders were significant correlated with accidents.

Kay Fitzpatrick described a study of "Countermeasures to for Truck Accidents on Urban Freeways", a survey of some practices. It included lane prohibitions, usually done without any detailed study or evaluation. I5/405 near Los Angeles have truck bypass routes, and the New Jersey Turnpike only allows cars in the express lanes. Truck tipping signs or "Too fast" flashers are generally considered fairly ineffective. One state allows trucks to use park-and-ride lots at night, to avoid them parking on freeway shoulders. Illinois DOT has its own heavy duty tow trucks for incident management.

Finally, Murray McLeod presented "The Characteristics of Commercial Vehicle Drivers in Ontario" on behalf of Julius Gorys.

Session 53 : Truck-rail Trade-offs in State Transportation Planning : Impacts of Truck Dimension Changes on Rail Traffic

Don Ward from Iowa DOT spoke about :Structure and Perspectives for Consideration of Truck Size and Weight Proposals", an effort to prepare the state to respond to any change as a consequence of the recent U.S. federal highway re-authorization bill, using the Turner Study as a model. They predicted $62 million immediate costs for bridges and ramp widening. They felt that measures to mitigate accidents were beyond their control, and should be a part of any federal prescription of vehicles. They did not foresee any great saving in pavement cost, as the trucks would primarily be long-haul.

Joseph Schwieterman addressing "State Highway User Fees and Efficient Movement of Heavy Freight : Implications for Michigan's Railways" noted that they were re-thinking their gas taxes and license fees due to citizen pressure against the largest and heaviest trucks, those with 11 axles, in the face of the highest rail line abandonment rate in the U.S.

Carl Martland spoke about "Northeast Regional Perspectives on Truck-rail Trade-offs", a study by a consortium of northeast states, concerned about the decline of the rail system. He suggested that any under-payment of highway use fees by trucks is not a real concern, as it would only have a very minor effect on freight if corrected. The northeast states had tried to consolidate the railroads, but there are now 27 operating! The heavy freight is in wood, pulp, paper and chemicals, but there is too little freight to

challenge the capacity of the rail system. It is not practical to put this on the railroads in the northeast as distances are only 2-300 miles. Most rail traffic is local, to access the national network. State railway people tend to focus on main lines, whereas regional development tends to occur on very low density branch lines. He suggested good service should be ensured for major development areas, including access to the national network.

Hoy Richards spoke about "Development of a Multi-modal Framework for Freight Transportation Investment : Consideration of Rail and Highway Tradeoffs", a recently-started NCHRP study. He suggested a national plan was necessary before states can realistically address local and regional issues, but that both the AAR and the DOT do not want to designate national route networks. He cited the fact that many states have departments of transportation and still-powerful railway commissions as the kind of institutional barrier that needs to be addressed before significant progress can be made.

Committee Meeting A1B04 : Vehicle Size and Weight

Peter Griskivich has arranged that the committee can sponsor a truck-roadway plenary session at the 1992 SAE Truck and Bus meeting.

A sub-committee of this committee is now planning the International Symposium on Motor Carrier Transportation, scheduled for Williamsburg, Virginia at the beginning of June 1993. I have been asked to be on the program committee for this conference, which is shaping up to more industry-oriented than the quite technical Kelowna conferences sponsored by TAC.

The updated TRB circular on heavy truck research is now in final draft form.

Joe Morris of TRB reported that their strategic review of freight transportation, basically a laundry list of prioritized issues, could become a policy study for truck-rail competition.

Bob Clarke of NHTSA reported that the highway re-authorization bill was now passed. It imposed a freeze on further use of LCV's, and states had until 1 June to submit a list of current routes to DOT. It also required several studies, of the safety of LCV operations by GAO; of LCV operator training by FHWA; and of needs for training for all truck drivers, by FHWA. In addition the Secretary of Transportation was required to set up a research council for two years, and a permanent research committee.

In addition to TRB business, Elaine King reported that the NCHRP program had been expanded from $8 million to $14 million per year.

Paul Fancher of the University of Michigan had been sponsored by TRB to produce a synthesis of truck operating characteristics. The committee, and I, contributed suggestions to this work.

Rob Harrison of TTI made a presentation of the impact of LCV's on interstate bridges. This was a continuation of work presented last year, then sponsored by AAR.

Finally, it was agreed to schedule a mid-year meeting, again the day after the MVMA/DOT meeting, which would be 16 July 1991, in Washington.

Finally, Mike Walton stepped down as chairman, and was succeeded by Alan Clayton of the University of Manitoba.

Session 100A : Status of the Nation's Highways and Bridge sand Relation to Re-authorization Legislation

Harry Caldwell summarized the 1991 status report on highway condition and performance, that FHWA is mandated by law to produce every two years. He reported that highway condition was now largely stabilized, due to previous 3R programs. About 91000 of 576000 bridges are obsolete, and 134000 are structurally deficient, of which about 20000 are on the interstate and primary highway system. Addressing such needs may be difficult, as local roads are 69% of mileage but carry only 13% of travel. Safety continues to improve. He noted that new capacity will be needed in areas that will become suburban in the next 15 years. He estimated that in 1993/4, they could be spending at a rate that provide some options to improve the (notional) national highway system.

Various panel members essentially complimented FHWA on the best of 11 such reports to date. They variously suggested that the report did not address the impacts of its own constraint assumptions; the legal requirement for six management systems (air quality, congestion, etc); and the data needs of these systems.

Session 105B : Unconventional Approaches to Vehicle Sensing

Peter Mills of FHWA presented an "Overview of Vehicle Sensing Technology". He suggested there are requirements for sensitivity to all traffic, including bicycles and high trucks. Low power consumption is really important for reliability. Hold time and processing algorithms are important to deal with stationary and slow-moving traffic.

Bob McQueen spoke on "The State of the Art in European AVI". He identified state-of-the-art automatic toll collection in France, Italy, Spain and Norway, based on vehicle transponders. He suggested that license plate image processing would never be more than about 95% efficient. Electronic toll collection could be used simply to generate revenue, or as part of a road pricing system to mange congestion. He suggested first generation transponders were dumb; second generation could store a temporary tag; and third generation could operate at 160 km/h with no need for lane channelization. In all cases, a secure two-way communication would be needed along the highway. Automatic debiting will drive development of the third generation, but will not be the only user. He suggested a universal smart card was feasible, that would maintain its own audit trail, and be good for both highway tolls and transit rides.

Bob Olsen described "Active Infra-Red Sensors". These can now measure vehicle length reasonably accurately from an overhead mounting.

Session 171 : Safety Effects of Roadway Design Decisions

Mark Marek provide the "AASHTO Perspective" on the issue. He identified that there are a hierarchy of differentiated design criteria, but that it is not clear which do most to enhance highway safety. When funds are limited, those criteria that appear to do least are ignored, in the absence of local information. He suggested that trying to bring old

state roads, up to 90% of road-miles, up to current standards would consume all 3R funds for the next 20 years.

Carl Robinson addressed the :Historical Background". It was not until the 1930's that safety issues were considered in design criteria, and FHWA did not establish its Office of Safety until 1964. Much of the current standards were developed in an ad hoc manner, and are not really well supported.

Joe Bared spoke on "Intersections". He stated that about 52% of all accidents occur at intersections, yet none of the intersection design criteria seem to have any impact on accidents.

Charles Zegeer gave an excellent presentation on "Cross Section and Alignment". He reported on a study that had correlated accidents with roadside features - recovery distance, a hazard scale (from 1=clear level, to 7=none) for 5000 miles of road rated every one-tenth mile. He showed the results as a nomograph, which suggested about 10% reduction in accidents per foot of lane widening; 6-8% reduction per foot of shoulder widening; 13-18% reduction per unit reduction in hazard index; and 2.5% reduction per foot of clear zone. Reduction in side slopes was very effective, but lanes and shoulders should not be widened at the expense of side slopes. Curve reduction is good, and spirals reduce accidents about 15%, and reducing deficient superelevation reduces accidents 10%.

King Mak spoke on the "Roadside", and his comments overlapped with the previous speaker. He said the roadside was involved in about 20% of accidents but 40% of fatals. If it is not possible to keep vehicles on the road then the consequences off-road on the vehicle must be mitigated by removing or relocating hazards; making supports breakaway; and protecting non-removable fixed objects with barriers and crash cushions.

Session 205 : Advancements in the Technology and Equipment for Automated Highway Traffic Data Collection

A paper by Curtis Dahlin described "A Proposed Method for Calibrating WIM Systems and for Monitoring that Calibration over Time". The method calibrates to the 3S2 5-axle tractor-semitrailer by monitoring weekly distributions of gross weight; daily average front axle loads for three gross weight ranges; and average ESAL's. For fixed weight and dimension regulations and enforcement levels, these quantities appear to be relatively time-invariant. This seems to serve more as a monitoring tool, as it was suggested that if current data did not match the historical pattern, that the WIM would more likely need to be repaired than re-calibrated. It was accepted that calibrating to 3S2's could introduce errors in other truck configurations.

Edward Fekpe presented the paper "The Progressive Sieving Algorithm : A New Procedure for Classifying Vehicles from Weigh-in-motion Data", of which I am a co-author. It was well presented, and appeared to generate considerable interest among aficionados of WIM.

Clyde Lee presented "Trial Implementation of a Photo-electric Sensor System to Classify Vehicles". The Oklahoma Turnpike has eight toll classes, based on number of axles and number of tires per axle. They have a voluntary AVI system for toll collection, and the transponders have pre-set classes. There was a need to audit the system, to ensure that a car tag was not used for a truck, and to audit the toll collectors.

Committee Meeting A2B08 : Vehicle Counting, Classification and Weigh-in-Motion Systems

Standards work is ongoing through ASTM. Their subcommittee E1742 has task groups now to develop common protocols for vehicle classification, classifiers, and AVC equipment.

A national WIM conference is planned for the week of October 25 in Sacramento.

NCHRP projects 3-36, on a bridge weighing system, and 3-39, on WIM calibration techniques, have been completed.

A joint one year evaluation of WIM and classifier systems by the states of Pennsylvania, Delaware, New Jersey and Maryland, on behalf of NASHTO, was described. There are 8 systems from 11 vendors now installed in I95/I495 at the Delaware border with Pennsylvania.

David Albright described a new strategic alliance between the state of New Mexico and Los Alamos and Sandia Laboratories and two universities. The state has put its highway system at the disposal of the other parties, who can now prototype and develop for commercial exploitation recently de-classified sensor and signal processing technology. This is the kind of technology used in the bombs seen in the recent Gulf war, which is patently generations ahead of current vehicle sensing technology.

Session 249 : Automated Highway Traffic Data Collection and Applications

I presented the paper "Applications of Weigh-in-Motion Data for Transportation Planning", jointly authored with Jerry Hajek and Gerhard Kennepohl. This certainly appeared to generate some interest, as despite the vast amount of effort devoted to developing WIM and capturing data, there really seems to have been very little actual use of these data.

Andy Nowak described "Truck Loads on Michigan Highways", analyzing data from both WIM and fixed scale in a manner that would be useful for bridge code calibration.

Wen-Min Pan described "An Automatic Vehicle Classification System for Toll Collection in China". The issues and design were essentially the same as those described in an earlier paper in session 205. However, the toll collector audit was the driving force, as typical truck toll charges are about one month's wages for the toll collector.

TRB '92

Planning

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Summary

This year, many of the sessions which I attended were either directly or indirectly associated with air quality. This can be attributed to the ever increasing concern with air quality in the U.S. One speaker noted that in the U.S. there are 57 non - attainment areas designated to be in the moderate, extreme and severe categories. In Los Angeles the air pollution is so severe that they have been given extra time to get it into compliance.

Improvements in air quality will come from a combination of vehicle technology improvements and transportation control measures (TCMs) such as implementing the use of HOV lanes. It is estimated that the combination of conservation and TCMs may be able to reduce fuel consumption by 10% - 20%. Technology improvements in trucks could reduce their emissions and fuel consumption by 15 % - 20%. Improvements in cars could reduce their emissions from 50% - 80% below the 1992 levels. While the electric cars mandated for California in 1998 will have zero tail-pipe emissions, they are not really zero - emission vehicles. Emission regulators are concerned with the NO_x and other emissions which will be produced by the electric utilities in supplying the electricity.

Sessions were given on potential improvements in fuel economy of cars and trucks. It was felt that it might be possible to achieve a Cafe standard of 35 mpg U.S. around the year 2010. Other sessions were given on new battery and fuel cell developments, alternative fuels and benefits of using reformulated gasoline.

It was clear that solutions were beginning to appear in transportation which would have a significant impact on improving air quality. As usual, it will be a question of cost and the time required to make the changes.

1/ Session 25: Issues in Transportation Energy Use

Three of the more interesting papers in this session looked at environmental and economic costs and benefits associated with improvements in fuel economy and vehicle purchases/scrappage.

In the first paper, T.F. Fwa and B.W. Ang measured the fuel consumption of a car as a function of the average traffic speed in Singapore. Their study found that fuel consumption of cars in traffic was given by:

$$F \text{ (gal/1000 mi)} = 23.0 + 266.7/V_T \qquad (V_T \text{ in mph})$$

The authors tried to account for the difference in weight of the cars in the study. Adding the weight variable to their analysis gave the following equation:

$$F \text{ (gal/1000 mi)} = 14.3 + 3.3065^{*}CID/V_T + 0.0044^{*}W$$

CID = Cubic inch displacement
V_T = Average speed (mph)
W = Weight (lbs)

The affect of other variables was also estimated. For instance, it was found that automatic transmissions consumed 0.78 ml/km more fuel than vehicles with manual transmissions. While the first equation only applies for the average mix of small vehicles in Singapore, the authors found that the coefficients in the first equation are similar to those developed for models for other cities.

The second presentation looked at the costs and benefits associated with improvements in the average fuel economy of cars. The work is part of a larger study being conducted by the National Academy of Science. The author, D. Greene, indicated that it would be very difficult to find the socially optimum value because of the large number of factors to consider. In the study, some of the factors considered were; price increase of cars, fuel savings, oil imports savings, transfer of wealth out of the country, safety, energy security, CO_2 reduction and emission reductions. The study looked at the costs of achieving a 32.5 mpg, 35 mpg and 36 mpg Cafe standard. Some of the assumptions used in the study were that yearly fatalities would increase at the rate of 1.34 per pound of weight reduction in cars and .447 for light trucks. Injuries would increase at the rate of 6.3 per pound of weight reduction in cars and 2.1 for light trucks. The value of a life was set at $2.0 M U.S. and the energy security premium at $5/BBL. Carbon had a value of $50/ton. A 10% increase in the fuel economy of cars would increase travel by 1%.

The analysis indicates that the optimum Cafe fuel economy is around 35 mpg for cars and 26 mpg for light trucks. He felt that this could be achieved through technology

improvements rather than shifting the mix of vehicles. These levels of fuel economy could be achieved in the 2000/2005 time frame.

The next speaker discussed the impact of fuel economy of car purchasing habits. The car companies believe that fuel economy is only important to those in the low end of the market. Also, buyers make their decisions before buying and 50% are brand name loyal purchases. For these reasons, the manufacturers feel that the fuel economy label is not useful and confusing.

The car dealers also believe that the fuel economy label has little value for the average buyer. They believe that it appears to be more important to buyers of import cars. The first four factors of importance to car buyers are; durability, quality, safety and performance. Fuel economy is ninth on the list. The low ranking of fuel economy is attributed to the significant increase in fuel economy which has occurred since 1974 and the low cost of fuel in the U.S. A car buyer's first decision is to determine the size of the vehicle which is required. This decision has the biggest impact on fuel economy.

The fuel economy of trucks has been improving, but this is due to the demand created by business purchases, not private buyers.

The next speaker, from the Environmental Protection Agency, spoke of the value of an accelerated scrappage program for cars older than 1970 from the perspective of emissions. They found that the average yearly mileage of 1970 cars is 4000 miles while that of 1990 cars is 13000 miles. The low mileage of the 1970 cars helps to offset their high emissions relative to newer cars. Production of emissions by all 1980 cars is about 25% more than 1970 cars and the 1980 cars as a group were the worst because of the combination of number of vehicles, mileage travelled and emission standards. The following data was supplied for the yearly production of all emissions by cars in the U.S.

1970	40 (Could not see units)
1980	50
1983	25
1990	10

The important attribute to note in the numbers is the steady increase from 1970 to 1980 and then the steep decline to 1985 and 1990.

In the test vehicle buy-back program in California, it was found that people who sold their 1970 cars were buying 1980 cars. If these people were also increasing their mileage at the same time to the average of that for 1980 cars, then slightly more pollution was being produced. This was of concern to the speaker. Ideally 1985 and newer cars should be bought. The EPA was assigning the following values to emissions to undertake their cost benefit analysis.

Hydrocarbons	$3050/ton
Carbon monoxide	$300/ton
Nitrogen Oxides	$2750/ton

The cost to remove the cars was estimated at $1.5B and the benefits were $1.9B.

The last paper looked at the use of energy in OECD countries and showed significant differences in travel demand and energy use relative to the U.S. The U.S. uses about 60 GJ/capita for travel while Japan and the OECD countries use 15GJ/capita. Travel demand (pass - km/capita) in the U.S. is double that of the other countries. The factor of 4 in energy demand between the OECD countries and the US is composed of factors such as; better use of transit, trains, less travel demand more efficient vehicles, etc.

In automobiles, over the past 15 years, the energy consumption has decreased significantly in the U.S. and has started to increase in Japan. In 1989, the fuel consumption of new automobiles was as follows:

Country	**Fuel Consumption L/100km**
U.S.	**9.5**
Japan	**9.0**
Sweden	**8.5**
Norway	**7.8**
France	**6.5**

The authors noted that the new car fuel consumption figures were currently changing very slowly compared to the steady improvements up to 1985. In some countries, Japan and W. Germany, fuel consumption has started to go up from the best years around 1982 - 1985. In Japan, the fuel consumption has gone from 7.8 L/100km in 1982 to 9.0 L/100km in 1989.

The authors presented data which showed a linear correlation between average vehicle energy consumption and gasoline prices. The authors believe that higher fuel prices makes car buyers purchase more efficient cars and makes the auto makers supply them.

2/ Session 83: Technology's Potential to Improve The Fuel Economy of Highway Vehicles

In this session, papers were presented on the potentiall for improving the fuel economy of cars and heavy-trucks.

The first paper in this session provided limited information in showing the potential for improving the fuel economy of cars.

The second speaker looked at technology improvements and the potential for weight reductions. He indicated that a 15% - 24% improvement was possible from engine modifications relative to engines in the circa 1988 model year. A part of this would come from multi-point fuel injection, ie. 2% - 5%, already included in many cars. The fuel economy of cars increases by 0.5% - 0.6% for every 1% decrease weight. He believed that it would be possible to achieve 46.5 mpg by reducing engine size by 70% and reducing weight by 50%.

The last speaker, D. Kulp from Ford, spoke about the technologies being investigated to improve fuel economy. Ford is investigating the use of the two stroke orbital engine to reduce the weight of engines. Two stroke engines have a power stroke every second revolution and theoretically produce double the power of the standard four stroke engine for the same displacement. Actually the benefit is closer to 1.5. However, the emissions of this engine are such that it could not pass the new emission standards.

They are also looking at the use of lean burn engines. However, the benefits are only on the order of 6% and it is difficult to meet the NO_x standard when insufficient CO is available to reduce the NO_x. He pointed out that the new Honda vehicle which uses a lean burn engine could not meet the California NO_x emission standard. This situation will also apply to the federally certified Honda vehicles in 1994 when the NO_x standards are made more stringent.

He then discussed Ford's plans to produce alternative fuelled vehicles. In 1991 they produced 250 Taurus flexible fuel methanol cars. This will be followed by 2500 taurus vehicles in 1993. Also they will produce 200 CNG Econoline vans in 1992 and an additional 200 - 600 in 1993. Ford is interested in alternative fuelled vehicles because they can be used to increase the Cafe standard.

He mentioned that Ford is concerned with the continuing increase in the use of accessories and their impact on fuel consumption. He is also concerned with the projections being made by "experts" and agencies because they have always been too optimistic. For instance, he listed the following:

Improvement	Prediction	Actual
Auto 4 Overdrive	**15%**	**5%**
Lean Burn	**13%**	**2%**
Front wheel Drive	**10%**	**2-5%**

In 1980, various agencies made predictions for 1990

Department of Transport	40 mpg
Office of Technology Assessment	38 mpg
Actual	**26.9 mpg**

He also took an issue with some of the current predictions. For example, one projection is that 4 valve engines will improve fuel economy by 5% and cost $175 per engine. Ford estimates that the benefit will be 3% and the cost will be closer to $400. He finished by saying that the auto industry had worked with the Stanford Research Institute to put together their best estimates. The study concludes that a realistic target for the year 2000 is 30 mpg.

Two papers were presented on potential improvements in the fuel economy of heavy trucks. The first author, H.M. Sacks, spoke of the improvements which occurred since 1982. In the U.S., combination trucks use 1.1Mbd of petroleum. This is almost double what it was in 1970.

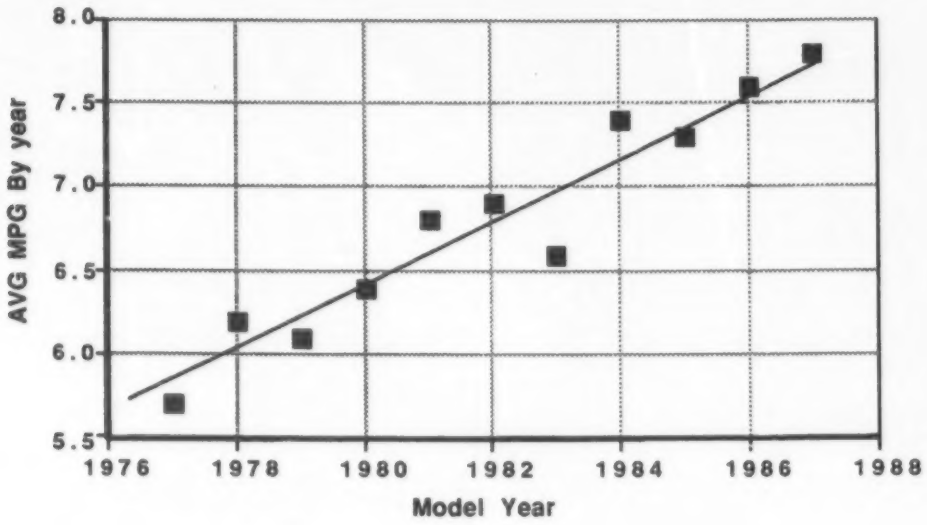
The baseline fuel economy in 1982 for heavy-duty class 8 trucks (W over 33000 lbs.) was 5.3 mpg (U.S.). The potential improvements for improving fuel economy above the 1982 value were:

Full tractor aerodynamics	**14%**
Trailer aerodynamics	**5%**
High Torque engines	**10% -12%**
Electronic engine control	**4%**
Drive train improvements	**5% -7%**
Tires	**3% - 5%**
Speed reduction	**15%**

The authors felt that it should be possible to get to 8.5 mpg with currently available technology. Production tractors are can now achieve between 7.7 mpg and 8.2 mpg. The authors conclude that through a combination of technology and speed control 8.5 mpg will be achieved.

The second speaker, on heavy duty vehicles, presented similar information on trucks but broke it down into three main categories; Class 7, Class 8A (33000 lbs - 50000 lbs) and Class 8B (50000 lbs - 80000 lbs).

For the Class 7 trucks, he presented the following graph which shows the slow steady yearly progress in increasing fuel economy.



Currently a class 8B truck achieves 240 ton-miles per gallon (U.S.) and he felt that this was a very energy efficient vehicle. Improvements on the fuel economy of these heavy trucks will be very difficult. Only small weight savings of the order of 300 lbs are possible. Most of the aerodynamic improvements have been achieved in today's fully "aeropackage" tractors. Low profile radial tires, which provide an 8 to 10 percent reduction in rolling resistance are now entering the market. Improvements in engines of 3 % - 4 % may be possible.

In summary, the possible benefits for Class 8B trucks are as follows:

Weight Reduction	**0.3**	**0.2**
Drag Reduction	**0.26**	**6.0**
Rolling Resistance	**3.8**	**6.0**
Engine Improvements	**7.0**	**6.0**
Drivetrain Friction	**0.5**	**0.5**
Electronic Control	**2.4**	**4.0**
Turbocompound	**0.2**	**0.5**
Sub Total	**14.1**	**25.2**
Emission Penalty 1994	**-3.0**	**-4.0**
Net	**11.1**	**21.2**

The author concluded that it may be possible to get a 1.2% per year improvement in class 8B fuel economy up to the year 2001. Further improvements would require the use of Twin 28s and Turnpike Doubles.

3/ Session 112B: HOV Systems: The Effects On Air Quality

The first speaker spoke of the use of HOV lanes in the Washington area as a transportation demand control measure. In the U.S., there are 57 non - attainment areas designated to be in the moderate, extreme and severe categories. The Washington area is looking at plans to install a total of 350 miles of HOV lanes. Currently they have 34 miles in operation and it is estimated that these 34 miles help to remove 1.8 tons of HC each day. They have to remove 40 tons per day to meet the air quality standard.

In the Washington area, the trip distribution is as follows:

Non - Work Auto	59%
Work Auto	35%
Truck	6%

Since such a high fraction of the trips are non-work related, the speaker felt that transportation control measures such as HOV lanes could only permit a small increase in travel demand.

He reiterated the need to combine parking privileges with HOV lane use. He said that at the pentagon, persons using HOV lanes got convenient parking places easily. Non-HOV lane users had difficulty in even getting the more remote parking spaces. He also felt that a metro rail system was more effective in attracting riders than HOV lanes.

The next speaker told of the small benefits associated with the use of HOV lanes in the Los Angeles area. He said that of the total 4.6 million vehicle trips taken each day, they were only able to decrease that number by 100,000 by installing their extensive HOV system.

The last speaker from the California Air Resources Board (CARB) spoke of all of the measures they were implementing to reduce pollution. Some of the initiatives on the vehicle side included:

- Clean new cars
- Clean in-use cars
- Clean fuels
- TCMs

They were also planning transportation system improvements such as:

- HOV system plans
- Better access to transit
- Integrated plans for bus and rail
- Trip reducing land policies

CARB is now looking at how speed and acceleration affects emissions. This is in addition to the number of trips, vehicle type and age. In Los Angeles, transportation contributes 44% ROG, 60% NO_x and 86% CO.

She broke down the emissions in a single trip into the following components:

	HC	NO_x
Trip ends	**53%**	**15%**
Vehicle miles	**42%**	**76%**
Congestion	**5%**	**9%**

It is the large HC component at the trip ends which is causing CARB to look at the use of heated catalysts, and lower RVP gasoline.

She felt that the benefits of HOV lanes were:

- Less cold start trips
- Less running emissions
- Less fuel use

4/ Session 142B: Alternative Transportation Fuels

The first speaker spoke of the rise and collapse of the CNG market in New Zealand. The rise in conversions was related to the incentives put in place by the government in 1983. Conversion could be obtained with no money down and a 10% interest rate. In 1984, 30,000 vehicles were converted. In 1988, the conversion rate fell to almost zero when the no money down plan was discontinued.

The next speaker tried to estimate the size of the electric vehicle market in the U.S. He laid down the following criteria for ownership:

- Must own their own place
- Must have a carport on the house
- Must have one long distance vehicle in addition to the EV
- One car must travel 80 miles per/day

By using the above criteria, EVs could be available to 27.9% of homes in the U.S. If the ownership criteria were relaxed to include rental units, the percentage would increase to 32.9%.

A paper, similar to the EV paper, was presented regarding the methanol market. The authors were trying to determine who would buy methanol and how much the consumer would be willing to pay for it. From looking at the sale of vehicle types, they determined that only 15% of the fleet needs premium fuel. In fact, 22% actually use it.

They then conducted a survey and found that:

- methanol had to be perceived as a premium fuel
- A significant number of drivers were willing to pay for its attributes, ie clean and high performance (associated with Indy cars)
- the target market was in the higher income category, better educated, had big cars and was of more interest to males
- There was some concerns regarding driving range, number of refuelling stations, maintenance cost, vehicle resale, safety and reliability.

The next speaker looked at the economics of using CNG in Texas. After showing an extensive analysis, he concluded that the price of gasoline was too low. To make CNG economic, the retail price of CNG would have to be lower than the current depressed prices in Texas.

5/ Session 194: Gasoline and Electric Fuel Cell Vehicles

Dr. Pandit G. Patil described progress in the design of fuel cells for transportation. The objectives of the program are to build and demonstrate fuel cell technologies and to conduct some field tests.

In a fuel cell, hydrogen and oxygen are combined to form electricity. The hydrogen could come from many sources. The fuel cell operates quietly, has no moving parts and is non-polluting. To make a fuel cell work, other auxiliary components, such as pumps, reformers and heat exchangers are required. The overall efficiency of a fuel cell can be about around 45%.

The benefits of fuel cells in transportation are:

- High fuel efficiency over the entire load range
  - higher than an internal combustion engine
- Very low emissions and noise
- Fuel flexibility
  - Methanol, ethanol, natural gas, hydrogen
- Lower maintenance costs
- Modularity and packaging flexibility

The program is evaluating different fuel sources and some of the attributes of the various fuels were outlined.

- Methanol
  - Easily transportable liquid fuel
  - Can be reformed in hydrogen at modest temperatures of ~ 200° C
  - Fuel cells operating on methanol have been demonstrated

- Ethanol/Natural gas/Propane
  - Require higher temperatures for reforming (greater than 400° C)
  - Reformer development just starting

- Hydrogen
  - No reformer system needed
  - Alternative storage methods under investigation (metal hydrides, cryogenic liquid)

The fuel cells can be used in buses, vans, passenger cars, trucks and trains. Once the proof-of-concept fuel cell is developed, it will be put into a bus. The bus design characteristics are specified to be:

	Fuel Cell Bus	Diesel Bus
Size	**27 ft, 24 seats**	**28 ft, 24 seat**
Weight	**19,025 lbs**	**17,000 lbs**
Acceleration		
0 - 20 mph	**10 sec**	**10 - 12 sec**
0 - 40 mph	**33 sec**	**34 -46 sec**
Energy Consumption (% of Diesel)	**65%**	**100%**

Dr. Patil said that they were aiming to have their demonstrator ready by April 1993.

The next speaker spoke of some consideration in the design of all - electric and hybrid vehicles.

For the all - electric vehicle, he felt that there were no serious questions with regard to motor power and torque, controllers, maximum battery power, transmission (probably none) or the motor type. The big issues continued to be battery weight and volume. However for hybrid vehicles, much optimization needed to be done.

Should a hybrid vehicle be powered by a series or parallel propulsion package? He felt that we were moving toward a series system as the components became more efficient. How should the power output be shared between the engine and the battery

system? He indicated that these were the type of questions that had to be addressed in designing hybrids.

Mr. Paul Nelson, from Argonne National Laboratory then spoke about advanced batteries for electric vehicles. The U.S. has formed the U.S. Advanced Battery Consortium (USABC). They have set battery development objectives for batteries for the mid and long term.

		Mid - Term	Long - Term
Power (80% DOD, 30 sec)			
/Vol	Watts/litre	250	600
/Wt	Watts/kg	150 - 200	400
Energy			
/Vol	Watthr/litre	135	300
/Wt	Watthr/kg	80 - 100	200
Battery Life	years	5	10

Current batteries have the following performance:

	kg/litre	Wh/kg
Lead Acid	2.5	36
Ni Cad	1.9	55
Ni Iron	2.3	51
Sodium Sulphur	1.0	81

He felt that a battery system would cost around $4000 and that EVs would have less driving restrictions put on them. Argonne has tested some small cells for advanced batteries and, based on that data, has made projections for the density, power, energy for the battery in 1998.

Projected Performance of Advanced Battery

	Battery power, 90 kw	Battery Energy, 40kwh	
Battery Type	**Density kg/l**	**Power W/kg**	**Energy Wh/kg**
Target (Long Term)	1.5	400	200
Tubular $Na/NiCl_2$	1.6	235	110
Bipolar $Na/NiCl_2$	1.8	380	170
Bipolar Li-Polymer	1.3	380	170
Bipolar Li/FeS_2	1.55	340	150

He concluded by stating that an advanced battery weighing 250 kg and containing 40 kwh (~200 - mile range) of energy could be available by 1998. However, he felt that cost would be more of a problem than weight or range by then. In reviewing the battery technologies, he felt that a bipolar battery showed the best promise.

Dr. Alan Lloyd then spoke of the role of electric vehicles in air quality planning in Los Angeles.

In Los Angeles, there are 13 million people driving 9M vehicles an average of 240M miles each day. Over the next 20 years the population will increase by 37% and the VMT will increase by 60%. Additional air quality improvements will not be realized without extensive new control measures, affecting many previously unregulated activities. Under the California clean air act of 1988, reactive hydrocarbons from motor vehicles have to be reduced by 55% by the year 2000. Other pollutants and air toxins also have to be reduced.

He showed the proposed standards for various Low Emitting Vehicles (LEV) to be introduced into California between now and the year 2010.

	NMOG (gm/mile)	CO (gm/mile)	NO_x (gm/mile)
1993 Standard	**0.250**	**3.4**	**0.4**
Transitional LEV	**0.125**	**3.4**	**0.4**
LEV	**0.075**	**3.4**	**0.2**
Ultra LEV	**0.040**	**1.7**	**0.2**
Zero Emission Vehicle	**0.000**	**0.0**	**0.0**

No dates are associated with the introduction of the various LEVs because in 1994, fleet averaged NMOG emission standards for new cars sold in California will be introduced. Based on the corporate average emission standard, it is believed that the fleet mix of cars sold in 2010 will be 50% ZEVs. The other 50% will be composed of cars running on alternative fuels (25%) and reformulated gasoline (25%). No diesels will be sold

Dr. Lloyd indicated that the air quality in Southern California has been improving since 1988. In 1988 the peak ozone readings were in the 600 ppbv range while today they are in the 350 ppbv. Some of the improvement is due to meteorology. While considerable focus is being placed on cars, he said that even if all of the cars were to be EVs, the ozone level would still exceed 120 ppbv.

The last speaker was Dr Albert Hochhauser from Exxon. He gave some preliminary results from the phase 1 tests performed with a range of cars and gasoline formulations.

The various fuels were tested on a fleet of 1983 - 1985 cars, 1989 cars and some flexible fuel vehicles. The vehicles were tested on a dyno and then the results were used to make projection for the cities of Los Angeles, Dallas/Forth Worth and New York.

	Air Toxics (%)	HC (%)	CO (%)	NO_x (%)	Ozone (%)
Reduce aromatics (45-20%)	-(30 - 35)				
Add MTBE (0 - 15%)		- (5 - 12)	- (8 - 18)		0
Reduce olefins (20% - 5%)		+ 5	0	- 8	- 20
Reduce sulphur (450 - 50 ppm)		- 16	-14	-10	
Reduce RVP 1 psi		- 6	- 8	0	

He concluded by indicating that ozone formation could be reduced by 28% - 37% by introducing reformulated gasolines today. An additional 5% - 9% could be achieved by 2005/2010. California will introduce such a fuel in 1996. The new recipe will reduce olefins by 50%, aromatic hydrocarbons by 25%, benzene by 50% and suphur by 80%.

Presentations and Preprints

1/ Comparison of Vehicular Emissions in Free - Flow and in Congestion Using Mobile 4 and HPMS

2/ Fuel Cells for Transportation

3/ The Role of Battery and Fuel Cell Powered Electric Vehicles in Air Quality Planning

4/ Heavy Truck Fuel Economy: A Review of Technologies and Potential for Improvement

5/ Installation of a Particulate Trap System on an M.A.N. Articulated Transit Bus

6/ Estimating Automobile Fuel Consumption in Urban Traffic

7/ Driver Fatality Risk in Two Car Crashes - Dependence on Masses of Driven and Striking Car

TRB '92

Planning

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TRIP REPORT
1992 TRB ANNUAL MEETING

M. D. Harmelink

Some of the sessions and committee meetings attended, with highlights, were as follows.

1. Session 25 "Issues in Transportation Energy Use."

This session dealt with methods of estimating fuel consumption in urban traffic; costs and benefits of automotive fuel economy improvement; impact of fuel economy on new vehicle purchase; accelerated scrappage program for urban automobiles; and trends in energy use in passenger transport.

The first paper reported on estimation of fuel consumption in Singapore from survey data on vehicle types, fuel purchase records and trip characteristics, to calibrate an average speed model found most effective in assessing fuel consumption in large road networks.

2. Committee A1E01: Bus Transit Systems

New Items:

- The TRB summer meeting for the urban transit group will be August 16-19 in San Francisco, titled "National Conference on Advanced Technologies in Public Transportation." Abstracts are due by January 31, 1992.

- UMTA, now called FTA (Federal Transit Administration) is now embarking on a Transit Cooperative Research Program in cooperation with TRB and others, modelled on NCHRP, with a budget of $10M/year. TRB Publication - SR 213: Research in Public Transit, was described as the "bible" for the future program. An independent governing board will be set up; active involvement of transit properties is desired. A Transit Research Coordinating Council, chaired by Larry Shulman, Associate Administrator of FTA, will also be set up. TRB will work to establish an annual research agenda, and TRB/FTA/APTA will cooperate to disseminate results. Activities will include research, development, operational testing (demonstrations), syntheses of current practice and technology transfer.

- Trimet (Portland, Ore): Is working on integrated communications and dispatch for LRT, bus and paratransit services.

- SCRTD: Is moving toward AVLC.

- New York City: A study of overnight services is required.

- Europe: Needs are transit scheduling improvements (1990 conference in Montreal, 1993 in Lisbon) and coordination of transit and traffic control.

- LACTC: The transit industry needs to come to grips with IVHS.

- Chicago: experienced a 5-7% drop in ridership and revenue in 1991.

- New York: Skeptical of benefits of AVLC. Has operating demos of methanol, LNG buses.

- San Francisco: See little value in AVLC. Will buy no more diesel buses. Will be buying some trolleys. Leaving it to others to sort out alternative fuels.

- Norfolk, Va.: AVLC works well. Must sort out most important uses of voluminous data generated. Has converted whole system to operate on timed transfer basis, everyone seems happy with it.

- Los Angeles: Consultant recommended trolleys. Substantial public opposition due to visual impact of overhead systems. Might have to avoid overhead wires at intersections (!). Major purchase of trolley buses may or may not go ahead.

Now chairman Ken Stanley addressed what he saw as a major need in transit: a clear definition of when transit has done a good job; many possible measures could be used: cost-effectiveness, effects on congestion and air quality, number of passengers carried, system coverage, service reliability.

3. Session 49: "Update on International Developments in Intelligent Vehicle-Highway Systems"

Reports were made on IVHS Developments in Canada (by L. Sabounghi, Transport Canada), the UK, Europe, and Japan.

The UK report was on Trafficmaster, a system which has recently been implemented by the private sector to provide drivers congestion information on the motorway system. Infrared overhead detectors are strategically mounted over motorway lanes to provide speed measurements. The information is broadcast on a national basis to an in-vehicle receiver and display, like an intelligent pager. At present, 2000 users pay £300 for the unit and £17.50 per month; 80% of current subscribers are corporations. The government also uses the information to track congestion trends.

The European report covered main activities in 1991: the increasing visibility of the PROMETHEUS program, the efforts to get DRIVE - Phase 2 underway, and new interest and initiatives in road pricing and demand management, as some transportation planners are concerned that IVHS-originated efficiency may lead to greater road use.

A spokesman for Toyota reviewed the history and gave a future overview of Toyota navigation systems. Emphasis was placed on the need to develop standards for digital road maps, highway infrastructure and in-vehicle systems and human interfaces. This was followed by a slide presentation on ATIS systems in Japan.

4. Session 83: "Technology's Potential to Improve the Fuel Economy of Highway Vehicles"

This session was chaired by Ovi Colavincenzo of TT&E Branch, MTO, and is reported more extensively in his trip report. It was an interesting session, comparing projections by scientists, energy efficiency advocates and automotive manufacturers of the potential and cost-effective future fuel economy for automobiles and heavy trucks. Many other related issues were discussed, including:

- Where the gains would come from (engine size and technology, vs. vehicle weight).
- Is there a technical bias toward increasing performance rather than fuel-efficiency.
- If fuel efficiency improves, will truck drivers simply take the gains in higher speeds (= increased productivity)?
- Improvements in fuel efficiency may be eroded by other requirements/wants such as emission standards, crash safety, lighting, air conditioning, power steering, etc.

5. Committee A1E14: New Transportation Systems and Technology

- Upcoming conferences were highlighted:
  - Fourth International Conference on Automated People Movers, March 18-20, 1993, Las Colinas, Texas
  - IVHS Workshop - Public Policy Issues - Monterey, California - April 1992
  - LRT Conference - Calgary - May 26-27, 1992

- National Conference on Advanced Technologies in Public Transportation: See Report Item 2 above. Papers are wanted on technologies for the disabled, innovative fixed guideway systems, low floor bus technologies, clean air technologies, robotics, and facility operations.

- It was agreed this committee should have a role and be active in IVHS in Transit, in conjunction with other committees.

- It was agreed that the committee should continue to play a nurturing and evaluation role for new systems and technologies, spinning them off as they mature. The subcommittee on AGT - Major Activity Centre People Movers will be spun off as a separate committee.

6. Committee A5005: International Activities

The 1993 sessions sponsored by this committee will focus on Europe 1993: A variety of topics were put forward, including congestion, transport policy, rail policy, automatic collection of road tolls, transnational goods movement, deregulation of European airlines, and megaprojects: Chunnel; Great Belt crossing; proposed Alpine tunnels.

7. Session 132: "Intercity Rail Passenger Service Issues"

Papers covered European Railways in 2040, presentations on high speed rail in the Minneapolis-Chicago corridor and the west Taiwan corridor, and high speed rail demand and ridership estimates in the Texas and Quebec-Ontario corridors.

The role of railways in Europe is in flux, and models for the future are being examined. Growing air and road congestion is leading to additional emphasis on the rail mode. The need to preserve rail rights-of-way was stressed. Various optional models were presented.

The interesting part of the Minneapolis-Chicago paper was the analytical comparisons of the effects of 3 speed alternatives (moderate high speed rail, TGV and maglev) on travel time, capital and operating costs, ridership, revenues, and market shares. I have some data in scrawled form for anyone interested.

The Taiwanese are projecting a 354km HSR system along the west side of the island to be fully operational by 2000, with 10 stations (3 in Taipei).

The Texas paper described several ridership forecasting models, and developed some demand elasticities. An interesting side comment on the Boston - New York corridor was that the travel is now split roughly: 80% auto, 20% air. If a high speed-rail line were implemented, 83% of the passengers would be diverted from air, 17% from auto.

The Ontario-Quebec was similarly concerned with forecasting techniques and models. There was a lively debate between the authors of these two papers on appropriate methodology.

8. Special Session "Urban Transportation Data Forum: Congestion and Air Quality Management Issues."

Analytical requirements for the new U.S. Clean Air Act were reviewed. They will be extensive and demanding, and will push the state of the art of transportation forecasting models and also emission level forecasting models.

The new Clean Air Act will require unprecedented levels of data and modelling accuracy, and will require an effective marriage of transportation planning models, vehicle emissions models and models of the effects of transportation control measures. The act requires increasingly stringent measures to reduce area emission levels and achieve compliance, hence good baseline and milestone trend data are critical. Near-term analytical requirements include emission inventories, evaluation of transportation control measures (TCMs), VMT forecasts and tracking each year until attainment, and VMT and emission and congestion checks. The air emission models will be very challenging, and may have to account for vehicle types, VMTS, and emission rates over a driving cycle (cold start vs. running). Data for grid cells in an area will require time of day inputs of energy use and emissions which will require link VMTS and vehicle type information, by time of day; speeds; temperature; percent hot and cold starts and number of trips per cell. Further, the modelling and analytical techniques will have to be able to stand up to public scrutiny.

9. Session 167: "Communication Technologies for Comprehensive Traffic Applications in IVHS"

This session consisted of a series of presentations on various communications technologies for IVHS, such as microwave, cellular, infrared, two-way radio, satellite, and RDS/FM Subcarrier communications, each presented by an advocate and/or marketer of the technology. Various technical features and advantages and disadvantages were reviewed. Some developments on using cellular technology for automatic vehicle location were reported. Some notes, too detailed for this summary, were taken and are available if desired.

10. Session 184: "Technical and Policy Development in IVHS"

The best papers here were the first two. The first was by Kan Chen (University of Michigan) on Policy Implications of Driver Information Systems. Systems considered were (1) Toll Collection and Road Pricing, (2) Traffic Information and Route Guidance, (3) Driving Assistance, and (4) Business and Personal Information. The most important policy considerations in each category were as follows:

(1) privacy; standards; political acceptability.
(2) privatization; dual mode or not; multijurisdictional traffic diversion; multimodal inclusion
(3) standards; legal liability; distress assistance
(4) safety regulations and standards.

The second paper, on Standards for IVHS, reviewed some of the policy dilemmas in standard setting:

- difficulty in conjoining public needs with private sector expertise;
- the window of opportunity may be narrow, raising the dilemma of too early vs. too late.

Suggested lessons for IVHS and AVI (Automatic Vehicle Identification):

- where some users are proceeding with implementation now: an imperfect standard may be better than none (eg. NY, NJ Port Authority AVI project)

- where IVHS technologies involve end-user choice: development may be riskier, without standards

- where no end-user market: pressure to adopt standards is less critical, de facto standards may be ok

- other than AVI, IVHS market pressures are less and standards could be developed in a more orderly fashion.

11. Session 186: "Maglev Technology Assessment"

Because the US Transportation Authorization Bill includes $750M for high speed Maglev development, there has been a remarkable resurgence of interest in the subject.

Several of the more interesting papers dealt with:

- Use of existing ROWs for Maglev and route integrity considerations;

    . such use imposes substantial constraints and speed restrictions
    . jerk onset and appropriate maximum levels must be investigated
    . substantial difficulties with increased guideway span lengths for acute angle road/rail crossings.

- Low Cost Maglev (so-called) for the US.

This was an academic but interesting review of possibilities, although with some very optimistic assumptions. "Low Cost" was defined as meaning profit is possible. The region of profitability is a function of speed, as well as other factors. Keys to "low cost" were identified as: light weight vehicles for low guideway cost; average speed of 400 km/hr; super conducting magnets; linear synchronous motor; comfort, efficiency and safety. Objectives were set out for guideway cost (under $6M/km); capacity of 12000 pph +; fares half those for jet air travel; energy consumption half that of car or jet; attractive for trips over 1000 km; noise levels less than those of rail.

- Noise from High Speed Maglev

The conclusion was that from 150 km/hr upwards, where aerodynamic noise dominates, there is little difference between maglev and high speed rail, for Lmax passby noise and normalized train lengths.

12. Session 208: "IVHS Safety Assessments from Existing Accident Data"

The first part of this session, all I could stay for, was somewhat disappointing. The first paper looked at possible benefits of advanced anti-collision systems in preventing HOV lane accidents, as inferred from an analysis of police accident reports. The conclusion about how to significantly reduce accidents involved reduced reaction/response time, sharpened driver perception, and enhanced visibility in non-daylight. The accident reports were useful in identifying possible applicability of new devices, but did not permit determination of their actual ability of prevent accidents.

The second paper, though presented by an entertaining author, concluded that the data source selected was not suitable for assessing IVHS safety contributions. A useful list of hazards in estimating effectiveness was presented, however:

- Risk compensation by drivers: Can we estimate this?
- Habituation to use of the device: Does this happen? Effect?
- Are there wrong responses to a warning? How measure?
- Do the people who buy the device/system need it?
- Do the people who need the device/system buy it?
- Can accidents be generated by the device itself?

Papers, reports, documents collected:

1. Newsletter - SPEEDLINES, Volume 9, January 1992 by the High Speed Rail Association

2. Paper - "Public Sector RTI/IVHS Initiatives in Europe" by Dr. Christopher Querée, London UK

3. Paper - "Isolating the Seat Belt Virus in Vehicle Automotive Seat Belt Use: Assembly and Initial Examination of a Multisource Counterfactual Data Base" by E. Levine, Winnipeg and A. Basilevsky, Winnipeg

4. Paper - "The Acquisition of Pre-trip Information: A Stated Preference Approach" by John Polak and Peter Jones

5. Paper - "Bus Fare Payment by Credit Card" by Thomas J. Ross

6. Report - "In-Vehicle Navigation Devices: Effects on Safety and Driver Performance" by Safety and Traffic Operations Research and Development, Washington, D.C.

7. Paper - "Concept of Super Smart Vehicle System and Its AVCs Related Systems" by Sadayuki Tsugawa, AIST, MITI, Japan

8. Paper - "Simulation Evaluation of In-Vehicle Navigation Systems - Methodology and Application" by Abolhassan Halati and David E. Boyce

9. Paper - "Policy Implications of Driver Information Systems" by Kan Chen, Ann Arbor, Mi.

10. Paper - "Economic Evaluation of CNG Fleet Conversion and Operation" by Dean B. Taylor, Mark A. Euritt, and Hani S. Mahmassani

TRB '92

Planning

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Manager

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Re: **Transportation Research Board**
Annual Meeting - January 12 - 16, 1992

This report presents a number of highlights from the annual meeting. There were a record 250 sessions this year. TRB is growing so rapidly that the executive expects it will have to cap the number of papers published annually at 600. Surprisingly, the organization does not seem to be hampered by its size, and growth rate. For example, the data committee that I participate in is well run and has been breaking a lot of new ground in surveys and new data collection programs. The continued growth of TRB is also influenced by the high calibre of people that are working in the organization.

My report selectively covers some of the strategic overview sessions, sessions which dealt with the travel demand environment and high speed rail, and a number of papers that could be of value to the Ministry.

I presented a paper on the "Characteristics of Commercial Vehicle Drivers in the Province of Ontario in Session 13 for Julius Gorys and there were a number of questions afterwards on dangerous goods, hours of service, and survey methodology.

Copies of over 30 papers and publications were obtained and these are listed by subject area.

TRB Achievements of 1991

At the TRB luncheon, Mr. Mike Walton, the outgoing Chairman commented on the achievements of the past year. A strategic plan for the Board is now in place, and there has been a high degree of consensus and support nationally on the need for transportation research. Transit research will receive a boost with a new Co-operative Transit Research Program ($12-$15 million/year) modelled after the National Co-operative Highway Research Program. The SHRP program will be extended and a new IDEA program added for IVHS. The private sector is getting more involved in transportation research with IVHS America and the Centre for Asphalt Technology. Key strategic investigations include a national review of cross-modal data needs ("Data

for Decisions"), a review of air policy ("Winds of Change") and a review of high speed rail opportunities ("In Pursuit of Speed"). The observation was made that the transportation sector has to compete in attracting high calibre professionals and give more attention to their training.

Keynote Address on Clean Air Initiatives

The annual keynote address was delivered by Mr. William Rosenberg, Assistant Administrator for Air and Radiation of the EPA. He noted that transportation policy is being increasingly driven by air quality considerations. The two most significant pieces of legislation have been the Clean Air Act of 1990 and the Intermodal Surface Transportation Assistance Act of 1991. These have been geared to put in place a flexible and market- based incentive program that has been based on negotiation rather than litigation. The resulting 10-year action program seeks to reconcile autos and the environment. The major cause of the problem has been that in the US, the vehicle miles of travel (VMT) has doubled over the past 10 years and this has offset the improvements to air quality that have been made at the vehicular source. We now have nine major urban areas that fail to meet air quality standards. The action plan focuses on three aspects. First, the emissions from the 1994 autos will be two times cleaner than the 1991 models. Second, the new formulations of fuels will result in a 15% reduction of VOX and toxins. Third, states will submit plans to tighten up vehicle emission inspection programs - for 74 areas in particular. It has been shown that 10-30% of the vehicles on the road are causing the majority of the air quality problems. Apparently, the proper repair of cars has twice the cost effectiveness of reformulating gasoline.

The estimated benefit of the proposed program has been estimated as $25B/year savings. Mr. Rosenburg also billed the Clean Air legislation as a business opportunity for U.S. industry. Revenues for the pollution control industry will jump $50-70 Billion by the year 2000 and there will be 45-60,000 additional high-tech jobs created. New activity will result from the design of test equipment, the search for CFC substitutes, fuel improvements, and air quality scrubbers. But overall, it will bring an improvement to the quality of life in the U.S.

Major TRB Review of Data Requirements for National Transportation Policy Making - "Data for Decisions"

As part of their strategic planning process which resulted in "Moving America" in 1990, the US DOT identified serious deficiencies in data on the use and performance of the national transportation system. They requested an independent study by TRB of the data requirements to support strategic transportation policy making and to recommend organizational changes to make this data available on an ongoing basis. A special TRB report "Data for Decisions" has just been published.

A number of factors have given rise to the need for a major new approach to transportation data, and many of these issues have arisen in Ontario and Canada as well:

(1) Government organization by modal administration has resulted in insufficient attention to the extraction of multimodal data for passengers and goods;

(2) DOT funding of multimodal data dropped from 9% of data program spending in the 70's (about $1 million annually) to 2% in the 80's (about $400,000 annually). This came about partly because of deregulation and also because of budgetary cutbacks during the 80's;

(3) Transportation makes a major contribution to economic growth and international competitiveness. Yet the information on the availability, cost, and quality of transportation services, particularly on a multimodal basis, is weak. This makes it more difficult to measure overall transportation performance and to understand the relationship between transportation and economic productivity and long term growth;

(4) Safety is a top priority, but there is controversy between the relative safety levels of the truck and rail modes. The lack of good data makes it difficult to assess the effect of further relaxation of federal size and weight regulations for trucks;

(5) The Clean Air Act of 1990 has imposed some tough new regulations on transportation. Funding of new transportation projects is contingent on being able to demonstrate improvement to projected emissions in heavily polluted areas. But basic data is missing on modal emission levels (particularly by vehicle speed) and the factors affecting travel demand in growing urban areas. This will make it difficult to demonstrate transportation improvements that will comply with the Act;

(6) The proliferation of automobiles continues in large urban areas. However, comprehensive data on commuting delays and freight delivery firms for major urban areas, organized on a consistent basis is lacking. This makes it difficult to assess the relative effectiveness of transportation investment in highways, transit, and demand management;

(7) Intercity transportation is seen as a market for new aviation and rail technology. However, there is limited information available on intercity travel, factors that influence modal trip choices, and the costs of alternative modal investments. This hampers the policy analysis process and the determination of the best ways to meet future intercity needs.

The study recommended that a new Transportation Data Centre (TDC) be created with an independent director who will report directly to the Secretary of Transportation. The Director will be appointed by the President and given a 4-year term. The TDC will be given its own budget of $20M at the outset ($90M over 6 years) and will be independently funded on an ongoing basis.

A major objective for the new unit will be to establish a National Transportation Performance Monitoring System (NTPMS). The data collection work to develop this new system is intended to supplement and integrate in an umbrella fashion, rather than replace, the data collection programs that are already in existence with the DOT modal offices (e.g. FHWA) and the Federal Bureau of the Census.

The TDC will be modelled on the characteristics of other successful federal statistical agencies. It will have a clear mandate to develop system-wide multimodal data and analytic support for national transportation policy making. Priority activity will be the initiation of national passenger and commodity flow surveys.

The TDC will have its own professional staff on a permanent basis. It will identify data needs for the NTPMS and do its own data collection where necessary. A User Advisory Committee will be set up to help guide the development of the initial organization and its activities. Standards for data quality and for quality control will have to be put in place early.

A major product of the Centre will be a report every two years which gives an overview of the transportation system performance and impacts through summary indicators and trend data. It will present the state of the nation's transportation system. This report will be given wide dissemination to DOT management and staff and to outside agencies.

Tom Larson, the Federal Highway Administrator, spoke to the Session about the importance of this new national data initiative. We live in McLuhan's Global village. We must have better information on the current state of transportation and its effect on the economy. We must develop competitive advantage out of transportation.

While attending the Session on National Data Requirements, one could not help but reflect that the MTO, in its current process of reorganizing on multimodal lines, needs to assess whether it has in place the information mechanisms to get a multimodal overview of the state of transportation in Ontario. We have a unique opportunity at this time to streamline the transportation data that we collect into an integrated package, supplementing where necessary. The resulting knowledge base would help identify to policy makers, the strategic choices that will help shape Ontario's transportation system in the future.

"Data for Decisions" (TRB Special Report 234) is an excellent report and I would strongly recommend it to senior management in MTO.

AMTRAK at Age 20

Session 102 reflected on 20 years of AMTRAK service. It began with a review by Don Phillips, a journalist with the Washington Post, of the public and congressional perceptions of AMTRAK. He talked about the impact of the air and auto modes in becoming the modes of the public. But still the public will not let go of the notion that "If they run good passenger trains, the people would ride them". Mr. Phillips credited the Metroliner with having had a major influence on the rebirth of the passenger train. The perception of the passenger train has changed and there is a strong belief that the passenger train will thrive. This perception seems to have survived in spite of a generally poor service attitude on the part of railway workers, and labour unrest.

In fact, Mr. Clayton has set a goal for the passenger service that "AMTRAK will pay its way by the year 2000".

Ray Lanman spoke about Corporate Development in AMTRAK. A basic question is whether AMTRAK is a public service or a business. While it was created to operate like a corporation it must be realized that government will have to pay for any extra service that they want. Mr. Lanman outlined their revenue enhancement program. Under the Regan administration, AMTRAK found that its "gravy days" were over and it had to get into an aggressive cost-cutting program and an expansion of its revenue base. Four areas emerged as significant sources of revenue: (1) Mail or Express Service. AMTRAK is the largest surface carrier of US mail with $40M in revenue in 1991. (2) Real Estate Development. More than $37M is realized from land leases, sales, and air rights. (3) Communications product development. In the Northeast Corridor, the rail right-of-way has been used for the installation of a fibre optics cable through a leasing arrangement with NCI. AMTRAK also had surplus communications capacity which it sold to a competitor of NCI. This will bring in $40M over the life of the lease. All passenger trains in the Northeast Corridor are equipped with telephones. ($2M in revenue). (4) Operation of Passenger Services. Under contract, AMTRAK operates many services in the U.S. and for cities in the northeast in particular. Services include Boston (MBTA - $20M in contract benefits), MARC, SEPTA, New Jersey Rail, Orange County in California, Virginia Roadway Express, Dallas Rapid Transit, and California's Peninsula Commuter Service. There is a strong interest in future MAGLEV services and there is an agreement with the proponent of the Orlando service that AMTRAK will be the operator of that service.

Peter Appel spoke about Yield Management at AMTRAK, and how they maximize revenue from passenger operations. During the 70's, trains had excess capacity and fare-setting was unsophisticated. In the 80's more attention was paid to each city pair

market, and fare setting on a competitive basis. Today, yield management is a complex computer-based process.

The idea behind yield management is to develop a fare program that will maximize revenues and fill the available seats on the trains. If fares are too low, you lose revenue, but if they are too high, demand drops and you lose revenue. AMTRAK has studied advanced booking discounts and has developed discount curves, beginning 3 months before departure, which show the appropriate discounts to be offered over time for a city pair. The objective is to ensure that trains are full - that last minute passengers pay as much as they are willing to pay in a competitive market situation (i.e. with air and auto) and that early bookers are paying as much as they are willing to pay at a discount. With the many origin/destination combinations, AMTRAK has developed computerized fare-setting routines that are used by a yield management staff. Mr. Appel claims that the current yield performance of AMTRAK is actually superior to that of the airlines.

Forecasting High Speed Rail Ridership

Dan Brand discussed 3 different approaches to forecasting high speed rail ridership. Method 1 treats all modes together in a single forecasting operation. Method 2 does pairwise splitting, first to separate auto and common carrier markets, and then separates rail ridership out of the common carrier market. Method 3 forecasts the future ridership in each of the existing modes and then determines the share that could be diverted to High Speed Rail. Mr. Brand indicated that Method 1 has a mathematical structure which predetermines the market shares that will be diverted to High Speed Rail from the auto and air modes. For example, if the current auto/air shares are 80/20, then the diversion to HSR will also be 80/20. Method 2 may underestimate HSR ridership because of the way the final step in the process splits between HSR and air. Mr. Brand recommends Method 3, maintaining that the air and rail shares are kept in more equitable balance throughout the process.

Frank Koppelman then presented his paper on the forecasting model which was recently used for the Windsor/Quebec City Corridor. His model, a multinominal logit model, was based on Method 1. He maintained that the criticism of the method by Mr. Brand wasn't warranted, because of the way the model is applied using aggregated traffic zones, whereas the model was calibrated with disaggregate data. Mr. Koppelman also suggested that a particular method should be used until an improved method can be demonstrated.

I was intrigued with the Koppelman/Brand discussion and have worked enough with the Koppelman results to feel that the multinomial logit method has worked quite well as a first-cut approach. But for the next phase of the Windsor-Quebec High Speed Rail

study, we would be remiss not to look in greater detail at the relative merits of methods 1, 2 and 3 to see if the current method can be improved.

Limits to Privatization of World Transportation Systems

This session was an International Roundtable. Privatization is becoming a popular approach to funding transportation on a worldwide basis, but it raises the question about the appropriate role of government in the funding of rail, highway, water and air transportation.

One of the most interesting papers in the session concerned some recent successes in Norway. Mr. Ostmoe, Director of Norway's Institute of Transport Economics indicated they have managed to almost double, over the past 5 years, the level of annual capital expenditures on transportation in Norway. The new sources of funding include: (1) local initiatives, private or public, (2) financing by banks, often through bonds, and (3) road tolls.

The new funding systems recognize the risk taken in each situation and in many cases have set up the Norwegian government to take the risks. But the central government will not be a guarantor for local initiatives.

Oslo has implemented a highway toll collection system for cars approaching the city. It started as a manual system in February 1990 and moved to an electronic system the following December. Revenue from the tolls are used to invest in roads in the cities and surrounding areas. There is still some controversy as to whether any of the funds should be used for rural roads.

Stephen Lockwood outlined a number of criteria for the private funding of projects. These included: (1) carefully structured risk/reward framework, (2) legal framework to provide resolution mechanisms, (3) consideration of public and private objectives, (4) predictable and adequate demand for the transportation service, (5) stable political/legal/policy environment, and (6) maintain effective real life competition.

There was a very spirited debate during the discussion period concerning the extent to which either the government or the private sector operate in the best interest of the public.

Urban Transportation Data Forum : Congestion and Air Quality Management Issues

The Intermodal Surface Transportation Efficiency Act (ISTEA) was passed by Congress in late 1991. It will shape future federal and state funding, and much of that funding will depend upon compliance with national air quality standards.

Metropolitan Planning Organizations (MPO's) will have to be certified for compliance with the new law in areas with over 200,000 population. Failure to comply after 1995 will result in federal funds being withheld.

One special fund being provided under ISTEA is a $6 billion Congestion Mitigation and Air Quality Improvement Program. Urban non-attainment areas within each state will compete for these funds to carry out congestion management and pollution reduction activities.

At the forum there was considerable discussion about the need to measure and monitor transportation activity: vehicle miles of travel (VMT) by hour of day and vehicle type, cold starts, acceleration locations, and transportation control measures. Current sources of data give only a part of the picture, e.g. highway link data or Place-of-Work data.

Some concern was also expressed that the new legislation assumes the availability of excellent transportation data and an ability to measure and model urban air quality with great precision. In fact, current data of urban transportation activity is collected relatively infrequently (for example, Census Journey-to-Work data every 10 years), air quality data often has questionable accuracy, and the modelling of urban pollution levels is still in the early development phase.

There is no question that the ISTEA legislation is going to generate a new wave of technical activity by government and consultants in the areas of urban transportation modelling and air quality projection.

Advanced Logistics and Communications in Road Freight Transportation (OECD)

The OECD will be releasing in about two month's time a report on the above. It will present a review of new communications technologies as they affect road freight and demonstrate how this is affecting production and physical distribution, and the highway role in this process.

Large multinational firms are at the root of the revolution that is taking place. The new scope of operation has resulted because of financial deregulation and the advent of new communication and production technologies. Electronic Data Interchange (EDI) which links companies by computer has become standardized as a means to transmit purchase orders and invoices. Firms now need this capability to survive in the 90's.

Information technology is now linking every part of the production cycle including marketing manufacturing, sales and service. It links suppliers and competing manufacturing firms. Transportation, particularly with just-in-time deliveries, has become an integral part of the production process. Even proposed IVHS systems are

seen as potentially providing transportation information that will facilitate the overall production/transportation process.

David Willis of the American Trucking Association talked about the results of a survey of 64 trucking companies to determine the communications technologies in use. The systems being used included: (1) Computer-Aided Dispatching, (2) Two Way Text Communication, (3) Automatic Vehicle Location, (4) In Vehicle Map Display, (5) Automatic Vehicle Identification, and (6) Real Time Traffic Information. Of these, the CAD was the most popular and effective. Two Way Text Communication seems to have better potential than voice communication, which may have some safety-related problems.

Concluding Remarks

The Transportation Research Board Meeting was like a 4-day MBA course on current developments in transportation. It provided an excellent overview of state-of-the-art developments in transportation technology, planning, policy, forecasting, and data collection methods. Of particular value were the contacts established with people who are addressing the same issues we are dealing with at the Ministry.

M. McLeod
Manager

cc: D. Guscott
R. Girdhar
T. AppaRao
M. Goodale
A. Gerlewych
P. Suokas
J. Wong

Attach:
MM/pn

Papers and Publications from the 1992 TRB conference
(Copies of these papers can be borrowed from Murray McLeod in the Planning Division at 235-4077)

Transportation Economics and Finance

1. Road Pricing as a Means of Financing Investment in Transport Infrastructure, The Case of Oslo
   Farideh Ramjerdi, Odd I. Larsen

2. An Investigation of the Relationship between Highway Infrastructure and Economic Development in Indiana
   Paul C. Lombard, Kumares C. Sinha, and Deborah J. Brown

3. Introducing Congestion Pricing on a New Toll Road *Robert W. Poole, Jr.*

4. Implementing Electronic Toll Collection and Traffic Management Systems in New England
   Humphrey, Kanaan, Cunningham

5. Free and Paid Commuter Parking in the Washington Region *Jon Williams*

6. House Price Effects of Elevated Heavy-Rail Transit Stations with Respect to Neighbourhood Income Levels *Arthur C. Nelson, Ph.D., ASCE, AICP*

7. Is it Better to be Dead than Stuck in Traffic? *E. Hauer*

8. Regional Transportation Financing: The Southwestern Pennsylvania Initiative
   Rita Pollock, Lorna Parkins

Transportation Surveys and Forecasting Methods

9. A Methodology for Conducting a Transportation Survey of Persons with Disabilities
   Kathi Rose, Roy Lave, James Sugrue

10. An Analysis of a Choice Based Panel Travel Survey Sample: Results from the Puget Sound Transportation Panel

Ram M. Pendyala, Konstadinos G. Goulias, Ryuichi Kitamura, & Elaine Murakami

11. Use of an Activity-Based Diary to Collect Household Travel Data
Peter R. Stopher

12. Factors Affecting Automobile Ownership and Use
Panos D. Prevedouros, Joseph L. Schofer

13. Trip Generation: Different Rates for Different Densities *Panos D. Prevedouros*

14. Pitfalls in Travel Demand Forecasts: A Return of the Repressed
A.P. Talvitie, Youssef Dehghani

15. Traffic Forecasting in the Helsenki Metropolitan Area Transportation Study, 1988
Matti Pursula, Heikki Kanner

16. Improving the Average Travel Speeds Estimated by Planning Models
Dr. Richard Dowling, Dr. Alexander Skabardonis

Transportation/Land Use

17. Location Planning for Companies and Public Facilities: A Promising Policy to Reduce Car Use
Erik J. Verroen, Gijsbertus R.M. Jansen

Truck Transportation

18. An Economic Evaluation of the Fee and Fine Structure for Overloaded Trucks in Washington
Ken L. Casavant, Jerry Lenzi, Barry Diseth

19. Study of Truck Transportation of Hazardous Chemicals
Claire Starry, Kirland E. McCaleb

Transit Planning

20. Public Transportation's Future in the New York Metropolitan Region
Athanassios Bladikas, Ahmad Sadegh

21. Current Use of Geographic Information Systems in Transit Planning *Carol L. Schweiger*

22. How to Code Transit Access Links in Transportation Networks *Antti Talvitie*

Rail Transportation

23. European Railways in 2040 - a Report of the European Conference of Ministers of Transport *Aad Ruhl*

24. Disaggregate Choice for Rail Riders' Access Mode and Station *Antti Talvitie*

25. Forecasting High Speed Rail Ridership *Daniel Brand, Thomas E. Parody, Poh Ser Hsu, Kevin F. Tierney*

26. Implications of High Speed Rail Alternatives on Air Traffic in the Minneapolis - St. Paul to Madison, Milwaukee, and Chicago Corridor *Kenneth R. Buckeye*

Road Freight Transportation : Logistics & Communications

27. Overview of OECD Program in Logistics and Freight Transport (Tape) *Burkhard Horn, Claude Morin*

28. Summary and Findings from OECD Report on Advanced Logistics and Communications (Tape) *Hironao Kawashina*

29. The Role of Informatics and EDI in Future Freight Transport (Tape) *Michael Frybourg*

30. Applications of Advanced Logistical Techniques and Strategies: A global Perspective (Tape) *James Cooper*

31. Future Developments and Innovations in Advanced Logistics (Tape) *David Willis*

General

32. 1992 Publications Catalog *Transportation Research Board*

33. 1991 Course Catalog, The National Highway Institute *FHWA, U.S. DOT*

34. 1991 Summary of Progress

TRB '92

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235-5021

Executive Summary

There is an air of excitement in the Transportation community as a direct result of the recent U.S. Highway bill adaptation. IVHS (Intelligent Highways) will play a major role in many of the large infrastructure upgrades and construction now being considered or currently being designed. As an example, Arizona is currently designing $185,000,000 worth of highway construction, and advanced IVHS technology will be incorporated. Also, they are most interested in our RTMS microwave road sensor technology. Now is the time to exploit our advanced technologies and infrastructure to help define and set standards in order to export in North America and eventually World-wide.

The following is a brief summary of my trip to Washington.

Part I: Enterprise States Meeting

Enterprise is an informal coalition of states to test and promote IVHS technology through demonstration projects. The current membership include Michigan, Minnesota, Colorado, Iowa, Washington, Arizona and Ontario (not paid membership yet).

- *Enterprise invited a European representative from the "DRIVE" coalition for information exchange.*

- *Germany is trying AM digital transmissions in addition to FM RDS, but baud rate is only in the order of few hundred bits/sec vs. 300 bytes/sec of RDS.*

- *Colorado's I-70 "road to Ski resorts" corridor can provide RURAL and High altitude IVHS results.*

- *Minnesota "Guidestar" is a $50,000,000 4 phase IVHS program. It includes RDS-TMC, ATIS (traveller info) subprogram named "Genesis", and ATMS (traffic management) research involving Adaptive Control Logic (Scoot like).*

- *Michigan is interested in demonstration projects involving AVI (veh. id) technology with Ontario to expedite border crossings.*

Part I con't:

- *Arizona is interested in ATMS - FTMS (freeway management) and AVCS (Veh. control) technology. They are currently consulting with CRC (Castle Rock) with respect to IVHS type applications to its new highway designs.*

*** *Enterprise would like a formal Ontario RTMS presentation at its next meeting in Colorado on the 28th Feb. {NOTE: IVHS Standards 28th Feb. in Orlando}*

- *Gabe Heti of MTO (Ontario) suggested and coordinated a table of projects in figure 1.0. This will help coordinate efforts in setting demonstration partners.*

- *FHWA (US FEDS) and Transport Canada may be interested in funding some of the projects in fig. 1.0.*

*** *With respect to Geocoding, it was agreed that Minnesota, Colorado, Michigan and Ontario should form a subcommittee on location coding and will meet in Colorado on the 28 Feb 1992. The committee will be similar to the one for RDS-TMC, which I attended. Coding example for Europe and Minn. avail.*

Part II TRB conference:

-Session 27A Congestion Management:

. *Data collection is vital to an ATMS system.*

. *TRB subcommittee felt that State and local demo sites should set standards, with Federal co-ordination to set consistency.*

*** *All or most of the Federal funding avenues has been enlarged by 100%. eg. NHS national highway, STP surface transportation,... However, mandate has been modified (read increased) and all project spending will be subject to federal approval.*

-Session 15 New Technology in simulation:

. *Most interesting presentation in this session involves the use of Bio-feedback EEG to determine cognizance of traffic simulation scenarios for human driver performance measurement. This could easily adapted to IVHS product design and evaluation purposes. I discussed with Dr. Ruth Heron of Transport Canada about her paper and suggested possible future MTO project cooperation.*

Project Area	ENTERPRISE Participants								European Equivalent
	Michigan	Minnesota	Ontario	Arizona	Colorado	Iowa	Washington	Transport Canada	
Current Projects									
Portable traveler info		Genesis	Travelguide						PROMISE
Real-time traffic, urban	Direct	Genesis	MTIPS	Phoenix FMS	Denver Metro				3 DRIVE projects
Real-time traffic, rural	Direct	I	I		Aspen				GERDIEN
Sensors		I	RTMS	I	S/D				COMIS
Transit AVLC	Ann Arbor Travers Co.	Travlink	D						
Trucking AVI	I-75	HELP	AVI-Ontario, HELP	HELP/Crescent	Trinidad, HELP	HELP	HELP/Crescent	HELP, I-75	2 DRIVE projects
Border crossing	S		S	I	I		HELP		EDI
Paratransit operations	D	D	D	I	I				
Vehicle command/control	D (Industry)	I (Robotic vehicles)	I	MIDAS					PROMETHEUS CEDS
Real-time signals	FasTrac	I	SCOOT	RHODES	I				Turin (UTOPIA)
Route guidance	FasTrac		Travelguide	I					GLAMD/Ali-Scout
TMC	Direct	Trilogy	Travelguide	I (Phoenix FMS)	I (Statewide plan, Aspen)	I (AM data)			ATT-ALERT plus 10 others
Proposed Projects									
Rural IVHS definition	D	I	I		S	S			
Universal roadside processor									GERDIEN
TMC location coding	Direct	Trilogy	I/S	I	S	S			Rijkswaterstaat, ATT-ALERT
TMC/GDF	I	I	I/S		I				ATT-ALERT plus others
Electronic signage	IVSAWS	I			I	I	I = INTEREST S = STUDY		2 or 3 DRIVE projects, PROMETHEUS
Human factors	Industry/Univ.	I		I	I				HOPES
Vision enhancement	Industry		I						PROMETHEUS
Other Areas									
Safety steering	Industry		I	I	I				PROMETHEUS
City center AVI			I						Barcelona et al.
System safety				(FIG 1-D)					

Part II TRB con't:

-Session 42 Traffic Signal Systems

- *Research shows FLASHING mode of Changeable message signs most effective in diversion instructions.*

- *Arizona through its "RHODES" ATMS research is trying what they call Proactive control through Stochastic Traffic Equilibrium. The basic modules are from TRANSYT-7F, a most popular traffic controller software program.*

- *A paper was presented on Detector delay for right turn-on-red. The idea is to invoke minimal interruptions on main arterials, while allow for right-turn vehicles to enter.(if main arterial volume is too high for merging.) The essence of the paper is based on the delays..*

  Tot_d= td+tw+ta, where td=deceleration time,
  tw=wait time for gap,
  ta=acceleration time

-Session 69 Speed Limit Research

- *The research on 65 mph vs 55 mph in the U.S. yielded conflicting conclusions. In the State of Virginia the Rural Off Road accidents had gone up significantly, while not the Urban counterpart. In Ohio there were no significant increase in fatal or serious accident as a result of 65 mph limits. However, serious accidents on roads in Ohio that has remained at 55 enjoyed a 27% decrease. Perhaps rural roads are not well lit at night and higher speeds limits provide training for lower speeds. Perhaps findings are not statistically significant.*

-Session 109AB Traveller decisions with ADIS (not ATIS)

- *J. Adler of UC. Irvine presented an interesting notion that traveller develop a HIGHER level of tolerance for traffic congestion should ATIS diversion information be taken. However, they did not quantify the level of perceived stress. (See EEG approach above in session 15)*

Part II TRB con't:

-Session 109AB con't

- *Reliability of Real-Time Information paper by Hani S. Mahmassani should be renamed to Effect of Real-Time Information. It shows a decreasing exponential benefit vs. Market penetration of Real-time ADIS/ATIS devices. This is in complete agreement of MTO's ATIS research at Queen's, which concluded 25% market penetration will yield 90% benefits (read balanced road loads). Mahmassani's paper also stated that very high (>95%) market penetration could yield ADVERSE travel times. This phenomenon is called System instability in Electrical Control theory.*

- *An Oxford paper indicated that PARKING information should be included in any ADIS device. This is in agreement of Japanese surveys as well. Perhaps Canadian parking hardware vendors should be aware of this.*

- *Many of the ADIS papers need empirical data to substantiate theoretical premises. However intuitive, demonstration projects are still invaluable and irreplaceable.*

-Session 124 Communication for IVHS

- *Rye Case presented a paper on different media for IVHS communications, which include predictions from 1986. They were quite reasonable and therefore accurate.*

*** *Much opportunities here for setting standards, as infrastructures are generally flexible and has not been dominated by any to date.*

-Session 167 Communication technologies for IVHS

- *This session included ..*
  - *+microwave*
    camera links, FTMS...
  - *+cellular*
    veh-veh, veh-infrastructure
  - *+Infrared*
    veh-infrastructure
  - *+Two way Radio*
    veh-veh, veh-infrastructure
  - *+Satellite*
    commercial veh, infrastructure-infrastructure, GPS
  - *+RDS/TMC*
    low cost infrastructure-veh.
  - *+Cellular for AVLC (veh. loc.)*

Part II TRB con't:

-Visited Hughes ATMS hospitality suite

- *AVI tags (see author for example)*
- *ATMS packages (cameras, RF links, Recognition processor boards,...)*
- *Satellite earth station communication systems.*
- *Products are in pre-marketing stage, mostly off the shelf from existing subcontractors or defense. Transportation system integration experience limited.*

-Session 185A Artificial Intelligence for Transportation

- *NCHRP (US. Fed program) include AI for Transport.*
- *California (Cal. Trans) is experimenting with full Intersection network implementation.*
- *Most systems discussed are KBES knowledge based expert system. eg. Hughes system for ATMS operators with suggested message for changeable signs.*
- *AI. is still in its infantile stage.*

-Session 193 Bond Financing

- *Innovative financing for US DOTs are necessary for major projects as States typically are mandated to balanced budgets.*
- *Schemes include loans based on LIENS on*
  -zoned expansion of residential and commercial developments.
  -Sales tax income.
- *In California "proposition 13" restricts debt issuing bonds to tough guidelines, particularly sales tax lien schemes.*
- *Some example of sales tax liens project include BART (Bay Area Rapid Transit San Fran.)*
- *Another scheme include the sale of property and lease back arrangement. (Sounds like mortgaging the future.)*

Part II TRB con't:

-TRB Keynote Speaker

William Rosenberg, assistant administrator of the EPA (Environment Protection) spoke on the topic of the Clean Air Act and its impact. Although requirements are strict and cost are high, ($0.25/person/day) the benefits are enormous and environmental technology will spawn jobs and exports.

-Session 215 AVCS (veh. auto-control)

-PATH/IMRA (California/Japanese) co-op. project involve the use of a magnetic infrastructure @ 1M interval. Lateral accuracy of 25 cm, speed to 60 kph. (auto-steering/braking)

-Nissan uses Laser Radar (diode) for accel/braking control. (accuracy 15cm/300M) Cameras and pattern recognition is used for steering control. (+/-25cm) It is also their view that..
-AVCS Cruise control will be in operation by 2003.
-AVCS Steering " @2008.
-Highway infrastructure to guide by 2009.
-Full Autonomous (no driver) by 2020.

.MITI (industry technology in Japan) is co-ordinating effort in AVCS/IVHS in Japan. There were 60 million passenger vehs. registered in Japan during 1990.

-Session 242 Traffic Modelling and Control

- *Stochastic Simulation Model need many runs to get results. (vs. 1 long run)*
- *Run to Run variations due to microscopic nature.*
- *TRAF-NETSIM popular for research, but limited end user applications to date.*
- *Reduce Variance techniques can be used to quickly isolate "what ifs".*

-Session 237B Hazardous waste sites (for interest)

- *Slurry wall construction techniques for 10-7 permeability specs. ($8,000,000 tot. per square mile)*

PART III IVHS Standards Committee:

-European and Japanese in attendance.

+In Europe, there is a movement for harmonization for advanced transport telemetric. The JPC (Joint program committee) through TC278 (non-ELE) and TC114 (ELE) works with National standard committees like DIN, DKE,(German) and AFNOR, UTE (French).

+Standards are guidelines not laws.

+Europe wants to cooperate with IVHS America, and does not want to "reinvent the wheel" and like-wise. (note: Europe is generally accepted to be ahead in IVHS)

+DRIVE II is a set of demonstration projects in Europe designed to be "beyond research".

-In Japan, the emphasis is in ATMS, ATIS only.

+There are 150 traffic control centers in Japan.

+Urban mandate is carried by JHPC -police.

****Ultra-sonic detectors are standard in Japan, but overhead construction and single lane detection only.*

+Ministry of Construction has set standards in digital road maps, now at ver 2.0. They also set standards for loops and variable message signs.

+Commercially, there is a Data Road Map Association.

+VICS (veh. info. Comm. systems) is a direct descendant of RACs & AMTICs (previous IVHS national projects)

+JSAE (Japanese Society of Automotive Engineers) oversees VERI (Vehicle Road Intelligence Committee)

+VERI consists of WG1-4 (4 workgroups).
WG1=System Assessment, WG2= Human Factors, WG3=Standards, WG4=joint workshops.

Part III IVHS Standards:

-In North America:

-ASTM (American Standards in name, international in scope) co-operates with ANSI. They are currently working on AVI standards. A hotly contested area, much lobbying is being done. Some indications that some compromise scheme may allow more than one proprietary technology to be implemented at first.

-Rick Weiland IVHS Standards chair, noted that "World is run by those who shows up!"

-In the APTS (Transit) area, Paula Okunieff of Intermetrics presented findings in the APTS committee of IVHS. Copies are available.

**** There will be an ITE (Transport Engineers) meeting on advanced traffic detector technology standards in March 1992. More detail to follow.*

-Systems Interface subcommittee reported on review of the NEMA specs.

-Communications Sub-committee is working on a short range roadside communications application matrix. eg. data rate specs., driver information standards...

-Tom Dayharsh of Stanford Research (SRI) presented a comprehensive outline of IVHS standard needs. Copies are available after the official minutes of the meeting are distributed.

****. Next meeting of IVHS Standards on 28 Feb 92 at Orlando Peabody Hotel 8:30-noon.*

**** May meeting on the 18th @ Newport, July 22 meeting in Chicago.*

TRB '92

Safety and Regulation

L. Clifford
Head

Research and Evaluation
Road User Safety Office
235-4442

TRANSPORTATION RESEARCH BOARD
TRIP REPORT
JANUARY 12-14, 1992

Driving Simulators for Testing and Training
This full-day session was part of the 25th Annual Workshop on Human Factors. Its purpose was to look at what simulators can measure and to examine emerging roles for simulators. Eight different research and operational activities by various jurisdictions were presented.

In terms of teaching basic driver eduction for new drivers, simulation is not seen as having a significant role to play over classroom and in-car methods. It is however, advantageous for more advanced training of things such as freeway driving, skid control, etc.

In terms of rehabilitation, simulators seem to have a greater potential use. Dementia patients, for example, can be shown the errors they are making on a simulator, rather than in traffic conditions. Physically impaired drivers can improve performance by training on a simulator rather than in high risk driving situations.

There was agreement that simulators would never replace the standard licence tests in use. Regardless of how valid the simulator is, it would have no face validity ie., it was not a test of a person driving a real car. However, simulators may have a role to play in dealing with subgroups within the population. In California, for example, research is being conducted to see if a simulator can accurately determine, through pre-screening, elderly drivers who need to be retested. Medical referrals and collision repeaters might also be candidates for assessment through simulation.

Four video demonstrations of existing simulators were given. Current and potential applications for simulators include: lane control, unexpected traffic stimuli, rapid lane changes, attention switching, speed and gap choices, night performance, difficulty in scanning and complex decision-making.

Simulators of particular interest are the Atari which is now developing a five screen version with 230 degree vision and night time, fog, and snow simulation; and New York University's system that runs off a MAC using CDROM.

Papers Available: Driver Simulation Background Paper by Jim McKnight

Older Driver Safety, Mobility, and Assessment Needs

University of Kentucky's "A Time Progression Viewpoint of Accidents of Elderly Drivers" looked at accidents over time and found that there is a three times higher growth in older females driving than elderly males. More elderly people are driving due to an earlier age of licence acquisition, a higher level of motorization, and spatial dispersion of living patterns.

University of Western Kentucky and the Federal Highway Administration have been doing work on the effects of useful field of view on crash involvement. They found that older drivers tend to self-regulate when they have known eye diseases that impair their vision, but have difficulty in recognizing visual disorders in the first place.

"Subjective versus Objective Vision Capabilities and Driving Decisions" found that people tend to drive regardless of having had eye disease but, that females tend to restrict themselves more that men.

"Clinical and Functional Risk Factors for Accidents and Violations Among Older Drivers" tracked Iowa Drivers for 7 years to look at changes in driving patterns, licence restrictions, violations, and collisions. People who had had heart attacks during the seven year period tended to keep driving; those who had strokes, stopped driving. "Recent Changes in Driving Among Older Adults" looked at crash statistics over time and found that even though there are more elderly drivers on the roads today than in the past, their crash involvement is increasing, while other age groups has decreased over time.

Papers available: A3T52 Task Force on the Safety and Mobility of Older Drivers Newsletter

Chairman's Meeting, Vehicle User Characteristics Committee and Committee on Simulation and Measurement of Vehicle and Operator Performance

Key issues and needs for future TRB sessions were discussed, including IVHS and Human Factors, validation needs for simulation, automated highways systems and safety effects, and improved operator performance measurement. The details of these ideas are described in more detail in the following sections.

Committee on Simulation and Measurement of Vehicle and Operator Performance

The Committee summarized the results of the Human Factors workshop on simulation and the two TRB sessions that the committee sponsored. The committee identified 2 new subcommittees:

1) Subcommittee on Measurement of Operator Performance and Behaviour, and

2) Subcommittee on Simulation Validation.

The first will be concentrating less on simulation than in the past and more on performance measurement. The second committee will identify research needs in validating simulator findings.

Five presentations were made showing recent simulation technology. The technology state of the art is moving forward rapidly.

The "cadillac" simulator at Mercedes Benz in Europe is one of the most sophisticated simulators in existence. However, it takes numerous days to program in changed driving environments. The Multi-Gen system, for example, is a tool for creating three dimensional visual scenes. Once the simulator data base system is in place, it is easy to learn and use and can provide instant scene changes.

Reports Available: Simulator Technology: Analysis of Applicability to Motor Vehicle Travel

Meeting of Committee on Vehicle User Characteristics

The committee members gave feedback on the various human factors workshops that the committee had co-sponsored.

This year six papers were submitted to the committee for review compared to twelve last year. It is felt to be better to organize sessions and contact people to submit papers rather that a general call for papers.

Committees that have close liaisons to this committee reported on major initiatives. The Task Force on Safety and Mobility of Older Drivers is shifting in its focus slightly from safety to mobility needs of elderly drivers. The re-focusing has been happening since the San Diego conference in October 1990. The committee in Alcohol and Drugs has broadened its focus and has been looking at community based countermeasure programs and alcohol and recreational boating. The committee on Bicycling and Bicycling Facilities is very concerned about the effects of IVHS ie. re-routing expressway traffic into city streets when bicycle advocates are trying to create bicycle friendly cities.

The subcommittees of the Vehicle User Committee reported on the past year's work. The Forensic Committee is continuing to collect data about the kinds of human factors issues that researchers are being asked to testify about in litigation trials.

The NHSTA Driver Performance Handbook is collecting information/data an elderly research that has been conducted. The High Technology Driver Aids subcommittee will collect information on human factors interfaces with intelligent vehicle-highway systems. Applications of such technologies for enhancing human sensory capabilities, the processing of information, vehicle control, and traffic control will be the primary focus of the subcommittee.

Six topics areas were discussed for 1993 TRB paper conference sessions:

1. Cooperative Traffic Management Systems
2. Simulators to Measure Performance
3. Validity/Reliability of Fitness for Duty
4. Driver Inattention
5. What is a Good Driver
6. Validation of Simulators

Michigan then reported on four research studies, Ontario discussed its past and current workplan, and the committee discussed its tour of simulators in Europe.

TRB '92

Operations

I. M. Mouaket

Head

Operations Executive Support
Highway Program Analysis Office
235-4132

memorandum

TO: **Rob Lockhart,**
Technical Publications,
Research & Development Br.
3rd. Floor, Central Building.

DATE: January 30, 1992

FROM: **I. M. (Abe) Mouaket,**
Head, Operations Executive Support
Highway Program Analysis Office

SUBJECT: **71st. Annual TRB Conference**
January 1992, Washington, D.C.

Per Mr. Graham's letter dated 1992 01 21, enclosed is my report on the event. My attendance of the sessions was limited by the necessity to attend four committee meetings.

The following sessions were attended:

1. Strategic Highway Research Program: Implementing Asphalt Research Products;
2. Pavement Management Applied to Local, State, and Foreign Governments;
3. Pavement Performance and Pavement Management;
4. Data Requirements for National Transportation Policy Making;
5. The Application of IVHS to Multimodal Transportation Management.

The four committees attended were:

1. A3C05 Committee on Pavement Maintenance
2. A2D03 Committee on Characterisitics of Bituminous -Aggregate Combinations to Meet Surface Requirements
3. A2B01 Committee on Pavement Management Systems
4. A1D06 Committee on Transportation Programming, Planning, and Systems Evaluation.

Two papers were obtained:

1. **Humplick**, Frannie; "Identifying Error Generating Factors in Infra-structure Condition Evaluations"; and
2. **Patterson**, W., and **Attoh-Okine**, Busby; "Simplified Models of Paved Road Deterioration Based on HDM-III".

The following documents (reports/pamphlets) were obtained:

1.	FHWA-TS-90-051	*Maintenance on High Volume Traffic Roads -- Technology Transfer Workshop Proceedings* (210 p).
2.	FHWA-IP-89-025	*Operating Larger Trucks on Roads With Restrictive Geometry: Summary Report* (14 p).
3.	FHWA/NHTSA	*Proceedings of Symposium on Effective Highway Accident Countermeasures,* June 12-14, 1990 (162 p + Appendices).
4.	FHWA-TS-91-003	*Proceedings of the Symposium on Work Zone Traffic Control,* June 1991 (260 p).
5.	FHWA-TS-90-038	*Evaluation of the Pavedex Road Survey System in Iowa* (111 p).
6.	FHWA-HI-91-006	*Improving the Effectiveness of Public Meetings and Hearings* (197 p).
7.	FHWA-IP-86-2	*Culvert Inspection Manual* (205 p).
8.	FHWA-TS-90-041	*Value Engineering Study of Bridge Deck Maintenance, Repair, and Protection* (54 p).
9.	Fed. Transit Admin	Advanced Public Transportation Systems Project Summaries (12 p).
10.	USDOT/UMTA	*Mobility Management and Market Oriented Local Transportation* (48 p).
11.	USDOT/UMTA	Advanced Public Transportation Systems Program
12.	US Army Corps of Engineers	*Polymer Injection of Bridge Deck Delaminations Oahe Dam - Pierre. South Dakota Oahe Spillway Bridge* (22 p + photographs)
13.	SHRP	*Long Term Pavement Performance Information Management System: Reserchers Guide* (27 p).
14.	NCHRP/TRB	*Summary of Progress* 1991.

If anyone is interested in any of the above documents, please call me on 235-4132.

Some of the essential messages or themes that have been echoed at this year's TRB conference include:

1. **SHRP**

   SHRP will be terminated as scheduled in March 1993. It will not be dead but will be taken over by FHWA and AASHTO and will move into the implementation phase. For example, 22 products (a product could be a material, a test, or a piece of equipment) related to asphalt pavements have already been developed and strategies for their implementation are under development.

   Three ingredients were cited as critical for the implementation phase: 1)bringing the client in so that better acceptance of the limitations of the products is created; 2) implementing products fast (e.g. in 5 years instead of

15), otherwise interest may dwindle and the effort may be lost; and 3)finding product champions among states (as cost saving measure).

2. **Pavement Management**

States continue their effort to meet FHWA legislation requiring them to have a system in place by 1993 or else lose federal funding. The systems so far developed vary in complexity and capability. Two pieces of advice were continuously reiterated: simplicity of the system itself and continuous user training. The creation of a user support system is important to keep interest and enthusiasm going. Many have reported advantages from creating such systems, the most noted of which are the creation of a systematic method for considering all work and the elimination of bias in the analysis.

3. **3rd Pavement Management Conference**

MTO took the lead in organizing the first two conferences in Toronto; the third conference was to be arranged by the FHWA. FHWA subcontracted the arrangement of the conference to TRB. A TRB task force was formed for that purpose and Prof. Ralph Haas was appointed as chairman. The Task Force has had its first meeting and is considering October/November 1993 as the ideal date for the conference. Many locations have been identified including St. Antonio (Texas), Austin (Texas), Denver (Colorado), Minneapolis (Minnesota), to name only a few. Focus is on St. Antonio (Texas) but many matters related to the conference facility availability and capacity need to be clarified. The Task Force will be recommending a Technical Steering Committee to TRB for approval. Until then, the Task Force will continue to work on clarifying matters.

4. **Pavement Maintenance**

Over the years, different agencies have come to use personal definitions for the various seal coats and preventive maintenance activities. This situation has precipated communication problems and, hence, the committee responsible for this area has decided to develop a technical compendium of what each type of activity includes and its technical name – a sort of a dictionary of terms.

5. **Data**

Existing Data has been revisited from policy viewpoint and was found to be poor from the standpoints of: system perfomance information, key problem identification and trend monitoring. The identified weaknesses relate to availability, coverage, and/or quality. Not only the data was found to be inadequate for policy purposes but was also reported as weak in its structuring. Hence, the study recommended organizing data by system attributes, supply attributes, demand attributes, performance

measures, and broader societal impacts. Greater use of info technology was also targeted in the new strategy.

6. **Technology**

Application of advanced technologies to enhance efficiency of public and road transportation and to achieve more equitable charges for travel will continue. Examples of advanced technology application in transit systems aimed at charging fares by distance and time of day were presented. Reliance on public transportation for certain types of trips (particularly from suburbs to midtown) is not the most cost-effective way for moving people. Consequently, the jitney (share a ride taxis on fixed routes) is emerging as a consideration in urban travel and an alternative to buses. Technology is also being applied to bring to drivers more information about road conditions. In this domain, a study in North Carolina determined that audio systems rather than video display systems inside the vehicle are the safer way to go.

7. **Public Works Financing**

The new empowerment act in the U.S. encourages all 50 states to pursue public-private ventures in expanding their infrastructure. For example, Federal matching grants and/or state revolving loans for privately sponsored toll roads, bridges, ferries and tunnels and matching grants for public-private projects aimed at rebuilding or expanding existing non-Interstate facilities using toll financing are two strategies cited.

The U.K. has retained a consultant to help coordinate research projects into road pricing in London. Road pricing is currently being investigated as one option for traffic management. Advanced technology now has made it possible to charge vehicles variable charges by location and time of day without much delays.

Acceptance of private financing for infrastructure development is spreading worldwide, in places like Bangkok, Malaysia, Mexico and Venezuela.

8. **TRB Papers**

Traditionally, TRB published papers with information of lasting nature. In the last while, though, it allowed papers of special application (case studies) that are of limited application to be published in attempt to increase the communication within the technical community. Demands on publication has increased sharply and TRB has instructed its committees (the mechanism for paper review and approval) to go back to the original practice. Staff at MTO should expect tougher evaluations from TRB process in the years ahead.